ENGINEERING NEWS

M. DE LESSEPS has again indulged in prophesy, at a meeting of the *Société de Topographie de France* over which he presided on May 26 last. He first gave a description of the works aided by stereopticon pictures, probably from the same series of negatives from which we selected the views in our issue of two weeks ago. With each photograph M. DE LESSEPPS gave an explanation "which everyone could follow," offering convincing proofs of the activity of the work. "The sun", said he, "is our best co-laborer, furnishing to photography means to refute the calumnies of our adversaries." He then, amidst the repeated applause of the very large audience, affirmed anew that the canal will be open to "grand navigation" in 1890. "We shall triumph at Panama," added he, "as we have triumphed at Suez, and our success will be all for the glory of France."

IF the French people will continue to support him in the future as they have in the past, there can be no doubt that he will eventually triumph to the extent of opening the lock canal, but how will it be "in 1890", when the canal will not be much further advanced than it is to-day, and the hollowness and falsity of these hand-to-mouth predictions will be again apparent? As will clearly appear from the discussion of *Le Génie Civil*, which we translate this week, there remain between now and the end of 1890 *two* dry seasons of 4 months each, and *three* rainy seasons of 8 months each, less 2 months of the present rainy season which have already passed. Considering that what we have shown to be accomplished is the work of 7 dry and only 6 rainy seasons, what can be thought of such renewed extravagant claims after so many others have been falsified?

THE bill to authorize the canal lottery loan having passed last week it is announced by cable that half the authorized amounts, $72,000,000, will be offered on June 27, with a lottery scheme including three annual prizes of $100,000 each and three of $50,000. The price is not stated, but the subscription books are to be open in New York, London and Paris simultaneously, so that no American need lose the chance for a permanent investment if he wishes it. In the meantime a rather comical fact has been brought to light by M. MOUQUIN, a French actuary, who finds that the Canal Company has been almost as unfortunate in some of its purely financial calculations as in its estimates of cost of work. In its calculations for the "reconstitution" of its March issue of 350,000 bonds, the Panama Company made an error of $17,543,024. M. MOUQUIN sent a paper to the Senate Committee on May 25, showing, by detailed calculation, that the company's proposals which are to be on the same basis as the lottery loan of $144,000,000 contained glaring and gross errors under each of the heads of purchase of rents at 82.85 and 100 francs, the deficits being respectively $17,543,024, $15,029,603 and $15,966,007, so that the reserve of 70.28 francs per bond should be increased to at least 84.73 francs.

THE Tehuantepec Ship Railway project is still alive. The directors of the company organized by Capt. JAS. B. EADS, met in Jersey City, N. J., June 8, and gave the contract for construction to the Atlantic & Pacific Railway Co.; the work to be completed in 5 years. WM. WILLIAMS and Col. JOHN ANDREWS, of Pittsburg, Pa., were authorized to negotiate the bonds in America and Europe.

WORK on the Corinth Ship Canal is now making rapid progress, the reports being that nearly 10,000 yds. (7,590 cu. m.) per day of solid rock is being removed, 2,800 men being employed, and 15 locomotives. The entire length of the canal is 6.30 kilos. or 4.84 miles, the width is 40 m. and the depth 8 m. below sea level; the average depth remaining to be excavated over the whole work being 22 m., all in solid rock. This would indicate that there are some 5,550,000 cu. m of rock yet to be excavated, for which 3 years or say 900 working days are allowed, requiring an average of 6000 cu. m. per day, excavation. The deepest original cutting was 97 m. or 325 ft.

VERY little is heard of this canal nowadays, and we may briefly note its history. A French company was organized in 1881 with M. DE LESSEPS as honorary President. The right of way and uncultivated land in each side was given by the Greek Government, conditional on the completion of the work without subsidy. The capital was $600,000,000 and work began May, 1882. The work was not properly prospected and solid rock was unexpectedly struck, causing the first contractors to throw up the work, but in February last, after some months suspension, work was resumed under new contractors. The workmen are now mostly imported, the Greeks refusing to work so hard. Powder and dynamite are used in about equal proportions. There is deep water at each end of the canal, no harbor works being required. The opening of the canal will save "18 hours of general discomfort" to passenger boats from all the Italian ports to Constantinople and Smyrna. The dues will be low and all the commerce between the Black Sea and the Mediterranean is expected to use the route. The canal is also greatly stimulating the construction of railways.

THE Puerto Cabello & Valencia Railway, in Venezuela, which was formally opened Feb. 17, and commenced regular passenger service March 29, is reported to be doing very well, according to the report presented at a recent meeting of the company in London. The line is 34 miles long. At a distance of 23 miles from the coast there is a grade of 8 per cent. for 2 miles; this is operated by the Abt rack rail system, which is said to work very satisfactorily. Puerto Cabello is a good port, with 25 ft. of water alongside the quay walls and there is very little tide. The La Guaira & Caracas Railway, another Venezuelan railway, also an English enterprise, has had its usual troubles with landslides, which, with extensive repairs to locomotives and rolling stock, have caused considerable expense. In 1887 there were 250 landslips, of which 150 occurred between December 5 and 29; some of them were very small, but even these caused much delay and expense. The greatest trouble is caused when the slips occur between tunnels.

THE Committee on Ventilation and Acoustics of the House of Representatives has reported favorably the bill appropriating $150,000 to enable Dr. A. DE BAUSSET, of Chicago, to build an air-ship, provided that half shall be paid when $75,000 has been spent by the inventor with results that look promising to a board of engineers, and the other half only after a successful trial trip. It is perhaps the nearest to official recognition which any aerial navigation plan has ever got, and Dr. DE BAUSSET, no doubt, hopes to repeat the history of Prof. MORSE by astonishing the world. The "ship" is to be a steel cylinder with pointed ends, the air being exhausted mechanically. If successful, the Committee say, with perfect truth, such a scheme would possibly revolutionize transportation. The Committee append to the report a letter from the Chief of the Bureau of Steam Engineering, confirming the correctness of Dr. DE BAUSSET'S theory, but adding that he had not had time to study the details of construction of the vessel sufficiently to pass judgment upon it.

IN view of the fact that many of the eastern railway companies are building large lake steamers, and that they already carry a large part of the lake freight, private vessel owners about Chicago and other lake ports are claiming that these steamers will eventually monopolize all the lake trade, and also the seaboard traffic, and that the Erie canal, which extends from Buffalo to Albany, will soon be abandoned. The movement towards making the Erie canal unprofitable began when the Western Transit Company was established. The through rates of this company from western points to New York are as low or lower than any private owner can give, and it offers much more rapid transit. The canal traffic has been constantly falling off and the number of boats built per year grows less and less. The Erie canal port list is almost 40 per cent. less this year than last, and the large sum of money recently appropriated by the legislature for the improvement of the canal is practically thrown away.

PRELIMINARY work on the proposed tunnel under the St. Clair River at Port Huron has been resumed. The row of test holes on the line of the tunnel has been carried out 500 ft. from the shore on the Detroit side and 550 ft. on the Canadian side, leaving about 1,200 ft of the river bed yet to be tested. The developments so far are satisfactory, the measurements showing, it is said, more than the required thickness of clay everywhere, with no fault or break discoverable. The shoe on the American side was successfully put in place, and the shaft is now being excavated. A blower for forcing air down the shaft and the electric lighting appliances will soon be erected. Work has been temporarily suspended by a strike of the workmen for $2 per day, but this interruption will not be likely to continue long.

THE Argentine Republic is a favorite field for English investors, and new companies are continually being promoted in London, the greater number being either land or railway companies. One of the latest of these enterprises is the Santa Fé & Cordova Great Southern Land Co. which has been incorporated to purchase large blocks of land along the route of a railway about to be constructed from Villa Constitucion, on the Panama river, to La Carlota; the land is to be sold in small lots to farmers and immigrants and town sites are to be laid out at 12 stations on the railway. The company has a capital stock of $2,000,000. JOHN W. W. HOPKINS, of Buenos Ayres, is the Resident Engineer.

THE great MITKIEWICZ-BARKER Chinese concessions have resulted in a law-suit between the parties if nothing else. The Count charges Mr. WHARTON BARKER with having attempted to freeze him out of both his credit and his interest. The telephone concession was to be $\frac{1}{10}$ BARKER'S $\frac{3}{10}$ the Count's, and $\frac{6}{10}$, another party's, and they were to share in about this proportion in their enterprises. The Count in conclusion alleges that "immediate organization" is a necessity for "securing the grants" and that Mr. BARKER cannot be made to organize. Mr. BARKER claims that the Count was not to have anything to speak of, and that the various grand projects are not dead but in abeyance. It is admitted that the grants have been cancelled, but it is claimed that they can be renewed. It is sad to see American enterprise represented in China in such a pitiful fashion,

THE past week has been comparatively free from railway accidents. The most serious accident was a collision, June 9, between two freight trains on the Philadelphia & Reading Railroad, near Shamokin, Pa. The trains were badly wrecked. Four men were seriously injured, one fatally.——The engine of a train on the Brooklyn Elevated Railroad, Brooklyn, N. Y., was derailed at the sharp curve at Park and Grand Aves., June 12. The forward wheels mounted the rails but the guard rails prevented any serious accident, and as the train was moving slowly no damage was done.

THE following bridge accidents are reported:—The iron bridge of the Richmond & Danville Railroad across the dock near the ship locks, at Richmond, Va., gave way under a freight engine June 5, throwing the engine into the water.——On June 7, a freight and stock train on the Erie road collided on a bridge near Hancock, N. Y.; the middle span of the bridge was destroyed and ten cars thrown into the river.——On June 9, about 100 ft. of the bridge (trestle?) of the Milwaukee, Lake Shore & Western Railway across the Black river, east of Bessemer, Mich., were carried away by a jam of logs brought down by a flood. The structure is 800 ft. long and 70 ft. high.——On June 10, several bridges on the Big and Little Cabin rivers, in Indian Territory, were washed away by a flood caused by a water spout; the Missouri, Kansas & Texas road lost three wooden bridges and an iron bridge.——Bridges have also been washed away at Wesner, Neb.; Lake Linden, Mich., and Thompson, Minn.

GOVERNOR HILL has failed to sign the bill reorganizing the Board of Trustees of the New York & Brooklyn bridge, and consequently the bill fails, and the old body holds over for another year at least. At the regular monthly meeting held on the very day when the time for signing the bill expired, only 6 of the Trustees attended, the general belief having been that the bill would be signed. A special meeting is to be held next week. It remains to be seen what the Trustees will now do, and in the meantime it appears needless trouble to discuss the matter further.

New Reservoir at Nashville, Tenn.

BY H. DE B. PARSONS, M. AM. SOC. M. E.

The city of Nashville, having entered upon an era of prosperity and rapid development, has gradually outgrown its present water-supply, and to protect itself, it has undertaken the task of constructing a new stone reservoir of somewhat peculiar design, to be connected with a supply which will be ample to meet the city's needs for some time to come.

As a site for the new reservoir a bald hemi-spherical shaped hill was selected, lying south and easterly from the city and distant about 1¼ miles from the Capitol.

This hill is composed of a limestone rock in horizontal layers of varying thickness, and covered in places with earth and clay. On account of the rock being so near the surface, and also to secure increased head, it was decided to build above ground, the water being confined by a stone dam, as is shown in section in Fig. 1.

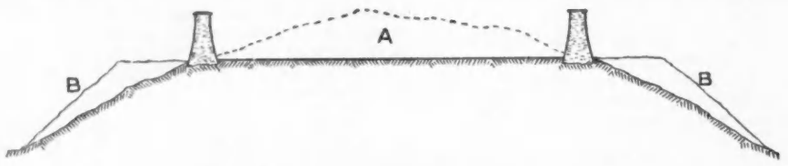


Fig. 1.—Section Showing Method of Excavating or Filling.

The walls are being constructed with the stone excavated at *A*, while the earth, clay and refuse rock taken from the center, are dumped just outside the foundations of the walls, as shown at *B*, thus forming a drive-way, from which a very beautiful view of the surrounding country is obtained.

The reservoir is approximately elliptical in plan, as shown in Fig. 2, with a central dividing wall, is the same as for the main one; but both its faces are arcs of circles having a radius of 74.56 ft. as shown in Fig. 4.

The walls rest on solid rock for a foundation, and consist of "squared" range-work, or, as it is sometimes called, "rough-ashlar." The stones are quarried both by steam drills (blasting) and by the "key and feather" method, mostly by the latter. In doing this part of the work, negroes are employed almost entirely, and give great satisfaction. They stand in gangs of twenty to thirty, generally in two rows along the top of the breast, and keep time so perfectly with their "*jumpers*" to an air sung by one of the party, that it sounds like one blow.

In this way, they unconsciously keep each other up to work, and so accomplish more than they ordinarily would; in fact, it is very interesting to watch the difference between the white and colored labor.

From Fig. 1, it will be seen that when the stone is quarried it is only a short distance from its place in the wall, and also that its haul is down hill. The cement used is Louisville, mixed 1 to 2 with sand. The mixing and gauging is entirely done by mechanical means, a small steam engine being used for the purpose.

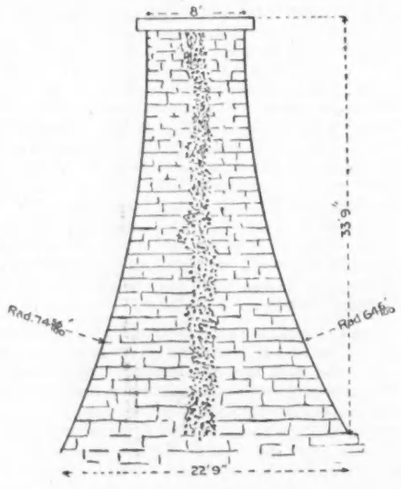


Fig. 3.—Section of Main Wall.

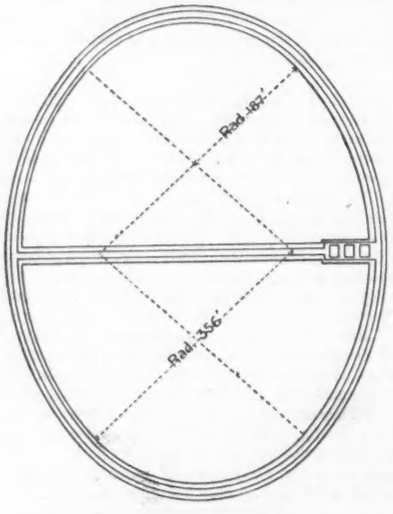


Fig. 2.—Plan of Reservoir.

and will have a total storage capacity of 50,000,000 U. S. galls. The major axis is 603 ft., and the minor 463 ft., both inside measurements. It is not truly elliptical, but a compound circular curve with radii 187 ft. and 356 ft. respectively, as shown. The main wall is 33 ft. 9 ins. high, 22 ft. 9 ins. at the base; and 8 ft. wide at the top, as shown in Fig. 3. Both faces are circular arcs, the outside one having a radius of 74.56 ft. and the inner one, 64.06 ft. The center of the wall has a core of rich concrete, 18 ins. wide, to prevent any leakage.

If the section of the walls had been triangular, with the apex at the center of the walk on the top, then we should have had a proportion of width of base to height of 0.67 or ⅔, which is the universally accepted figure for such a section. The extra material added near the top by the curved faces, helps to resist wave impact, affords thickness to prevent leakage, and furnishes room for a foot walk.

The dam, however, will not be strained to these limits, since the water will never stand as high as the top of the wall. The theory of the division wall

When the space between the walls has been entirely excavated and leveled, a concrete floor will be laid.

The use of the stone is furnished to the contractors free, and the prices allowed are 70 cts. per yd. for quarrying, dressing, excavating, removing and leveling; and $3.90 per yd. for the finished masonry.

The supply will be taken from the Cumberland river, there being a pumping station situated on an island a short distance above the city. Since the river water contains large quantities of sediment, especially for eight months in the year, it is passed through a filter bed of gravel and sand before it reaches the reservoir.

The height of the bottom of the reservoir is 277 ft. above low water mark in the Cumberland river, and from 100 ft. to 200 ft. above the different parts of the city.

Mr. J. A. JOWETT is Chief Engineer; Mr. H. P. B. RIGBY, Superintending Engineer; and Messrs. WHITSIT & ADAMS, Contractors.

The Supporting Power of Soils.*

It is often necessary for the engineer to prescribe a limit of load, per unit of surface, in designing foundations for structures resting upon soil. In the absence of the time and means to make actual tests of the soil, he must confine himself to an investigation of existing successful structures upon a soil as nearly similar to the one under consideration as he can find. It is the object of this paper then to present a few remarks upon the actual supporting power of soils as deduced from an investigation of the matter from our own observations, and the recorded examples which have been accessible.

It is probably possible to devise a general mathematical formula which would be applicable to the supporting power of any soil, but as such an expression would necessitate our knowing so many particulars as to the character of the soil, such as its weight and natural slope that we could judge of its actual strength fully as well without applying it. At any rate, we shall confine ourselves to-night simply to the practical side of the matter.

The Supporting Power of Clay.—The supporting power of clay is very variable and depends in a large measure upon the variety, and upon its degree of saturation with moisture. In the roadbeds of railroads, when the "surfacing" has been done with clay, a smooth, hard bed, unyielding and with far greater supporting power than would be required, is always found in dry weather. It becomes very compact, so much so that it is impossible to press the point of a walking cane into it. But after a drenching rain, all conditions change, and the roadbed becomes a mass of mud, into which the ties are pressed down and the clay bulges up between them.

We mention this simple example of dry and wet clay because it is familiar to most of us, and shows clearly the effect of too much moisture in such soil.

The clays vary considerably, however, in their chemical constituents, and are affected thereby in the degree to which they absorb moisture. Certain deposits are known to be compact and hard, with a high supporting power, while others are in the condition of a plastic material, easily compressed. But its chief characteristic which renders all clay more or less unstable, when regarded in the light of a foundation, is its known property of retaining water once admitted to it and its softening propensities, which gradually take place as the amount of water increases.

The stiff blue clay deposits of London are celebrated, as much for the numerous failures of the bridges and other structures founded on it, as for any other reason.

Old Westminster bridge had probably about 5½ tons per sq. ft. of foundation, and failed.

Blackfriars' bridge had about 5 tons and appeared to be stable for many years, but ultimately settled very badly.

New London bridge was built in 1831 and founded upon piles, upon which as much as 80 tons per pile was imposed. Of course, it has settled—in some places as much as a foot. The pressure per square foot of the entire foundation of this bridge is 5 tons.

When the new Westminster bridge was built the load per pile was reduced to about 12 tons, while the load per square foot of the entire foundation was reduced to 2 tons. I find no record of this bridge having shown any sign of settlement.

ROBERT STEVENSON [1] attempted to load a stiff hard clay with 5 tons per sq ft. He was building some high bridge piers at the time, but before they were completed serious settlements took place, and he decreased the amount per foot by making his foundation of greater area than first determined

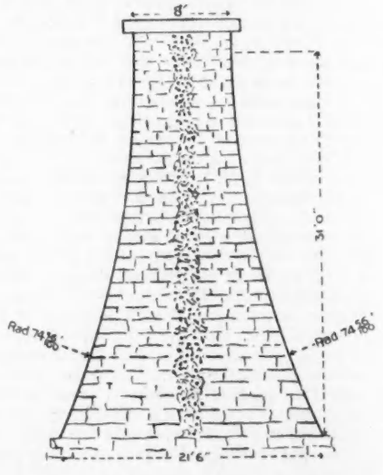


Fig. 4.—Section of Division Wall.

NEW RESERVOIR AT NASHVILLE, TENN.—J. A. JOWETT, Chief Engineer.

* A Paper by RANDELL HUNT, M. C. E., Soc., of St. Paul

[1] Trans. Am. Soc. C. E.

upon. He also built a large chimney which failed, and then constructed another, at Newcastle-on-Tyne, with only 1½ tons per sq. ft. of foundation, which was successful. Both these chimneys are described as being founded on hard compact clay.

The sub-soil of the vast valley of the Red River of the North, is a bed of clay, which varies in depth from 80 to 125 ft.—a bed of sand and gravel usually being found underlying it. This clay is generally of a yellowish color and appears more or less hard and firm in proportion to the amount of moisture contained in it. Chemically considered it has a large amount of carbonate of lime in it, as can be seen from its action when treated with acids; and when freshly opened up to view in a place where free from much moisture, appears about of the consistency of marl.

In 1881, at Fargo, Dak., a brick building, of four stories in height, including a basement story, was constructed upon a concrete foundation. The pressure per square foot upon the clay was at no place greater than 2⅛ tons, and was probably even less than this amount. The building showed a certain amount of settlement each season, until the third year after being built one side of it suddenly commenced to crack, and settled a foot or more in a single day, becoming so dangerous that the occupants were compelled to abandon it. The side which had failed was immediately torn down, a new foundation of broader dimension put in and the wall reconstructed. The load per square foot on the clay of the new wall is about 1½ tons, and as far as the author knows, it has remained intact. All along the side of the wall which failed was an open area way which was very imperfectly drained and we are inclined to think was the cause of the clay becoming softer than it otherwise would have been; for the other three sides of the building, while showing more or less settlement, yet remained comparatively in good condition.

In the city of Cleveland, Ohio, many heavy structures have been founded upon clay deposits, and one or two notable ones have shown serious settlements. In the new Central Viaduct, now being constructed, and the foundations of which were described in the *Journal of the Association of Engineering Societies*, the pressure per square foot of foundation on those piers and abutments which rest directly upon the clay has been limited to from 1 to 1.7 tons. The abutments which exert the largest load mentioned are described as resting upon "a mixture of blue sand and clay, with some water," while the piers giving a load of but 1 ton per square foot rest upon a "plastic blue clay of various degrees of stiffness, mixed with fine sand."

When clay is mixed with other materials, as coarse sand and gravel, its supporting power usually largely increases, being greater in proportion as the other materials are in excess, up to the point of forming a concrete mass, in which the clay is the cementing material, and in just sufficient quantity to bind the materials together. In this condition we often find the clay in an indurated state, and the hardness of the mixture—commonly called "hard pan"—is proverbial. Such soils are safe for heavy loads, approximating that of the softer rocks.

BRENNECKE, in his book on foundations, mentions a large chimney with a load of 6 tons per sq. ft. on hard clay. This is an extraordinary example, and we are inclined to think, though no further particulars are stated, that it was upon some such hard mixture of clay and gravel as mentioned. At any rate it would be a bad precedent to follow in loading beds of pure clay.

The Washington Monument is founded upon a layer of clay and sand. When the shaft was up 150 ft. an investigation showed that the foundation was entirely inadequate upon which to complete the structure—a committee of United States Army engineers reporting that such a soil should never be loaded above 10,000 lbs. per sq. ft. The foundation was therefore made heavier and larger, and the shaft successfully completed with a height of 555 ft. Col. CASEY, the engineer in charge, reports the pressures upon the soil as nowhere exceeding 9 tons per sq. ft. and less than 3 tons per sq. ft. near the outer edges.

The settlement of the monument during the repairs to the old foundations was about 2 ins., and afterward a further settlement gradually occurred during construction of 2 ins. more, making a total of 4 ins. If the load per square foot on the soil reaches the amount of 9 tons, it is the heaviest load upon such a soil which we find any record of, and we think the doubts expressed by different persons as to the ultimate stability of the monument entitled to careful consideration.

Supporting Power of Sand.—Foundations on ccarse sand and gravel are usually successful, particularly if free from the action of running water, and structures, proportioned in accordance with any ordinary rules of good construction, are hardly likely to have an area of base which will not be sufficient to limit the load per unit to the safe carrying capacity of the soil. Coarse sand deposited in beds has usually a high supporting power, but the coarseness alone is not proof positive of this, for it also depends somewhat upon how it has been deposited. On beds of sand made artificially, as is often done for foundations, the dry sand loosely thrown down does not form a compact mass, such as is desirable, and a certain amount of compressibility will exist.

In some experiments made in France with river sand, it was found that by pounding the sand in thin layers its density could be increased one-fifth, and that there still remained about 20 per cent. of voids which could be notably reduced by simultaneously treating the sand with water, while the stamping down took place. The compression was exercised in these experiments by means of hydraulic presses, and the results obtained showed that river sand treated as above would resist up to pressures of 1,420 lbs. per sq. in.

Water is the chief agent which makes the particles separate and draws them into the voids of the mass, and is invaluable in all works of embankment in which solidity is required; but it must also be well drained off, because if the original amount should remain, of course the mass of earth would continue in a semi-fluid state.

Mr. MACDONALD, in constructing the iron ocean pier at Coney Island,[2] assumed that the safe load per square foot upon the flanges of the iron disks, which were sunk into the sand, was 5 tons. But many of them really support as much as 6.3 tons continually and are subject to occasional loads of 8 tons per sq. ft. which they appear to sustain without settlement.

The foundation of the large chimney of the New York Steam Company,[3] was made of concrete resting directly on the sand of the old beach, which had formerly extended to this point. This sand was quite fine, with pockets of gravel, and containing at a few places some stone. The sand was thoroughly saturated with water, and would flow when disturbed or undermined. The load per square foot on this material was to be 4 tons, but before more than one-third of this amount was placed upon it, slight settlements occurred which were not uniform. After the structure was completed slight cracks appeared, but not sufficient to cause any material damage.

In contrast with the loading of the partly unstable sand of this chimney, may be mentioned the loads which were imposed upon a clean, coarse sand in the foundations of the Pacific Mills chimney,[3] at Lawrence, Mass. Here the sand was inclosed by tight sheet piling, and only 1.83 tons per sq. ft. placed upon it.

The anchorage of the Brooklyn bridge rests upon sand, with a pressure of about 4 tons per sq. ft. The Nantes bridge, constructed in 1863, and founded on sand, has a pressure of 6.78 tons per sq. ft., but has settled somewhat.

The safe loading upon the sandy soil of Berlin is generally taken at about 2.3 tons. BRENNICK describes this sand as being comparatively loose, but likewise mentions its having been successfully loaded up to 4.1 tons per sq. ft.

When sand is mixed with other materials, such as clay or loam, which have the power of retaining water, its supporting power grows less, and proportionally more so as the sand becomes finer and loses its sharpness. Of such a nature is the commonly called "quick" sand, which really occupies a position between pure sand and pure clay, being a mixture of them both. Pure clay is composed of alumina, water and silica, and in proportion as the silica is absent the more water will it hold. This is the material which, when mixed with the very fine and rounded grains of sand, makes it "quick". Deposits of such are often found, which through long draining have lost all the water, and which appear dry and loose, and easy to excavate or handle, and generally of a whitish color.

If we could keep such deposits absolutely free from saturation with water, we could trust it with moderate loads. Its weight is less than either good sand or clay, running from 70 to 90 lbs. per cu. ft.

At the foundations of the Capitol at Albany, Mr. W. J. MCALPINE describes some of the material as being quicksand without the water. Experiments made in the soil of this foundation showed that under a weight of 2 tons per ft. no perceptible displacement occurred; and at about 5 tons the surrounding soil was forced upward. It was endeavored to place no more than 2 tons per ft. upon the soil with the completed building, and great pains were taken, by means of spreading gravel 6 ins. deep over the whole area, and inclosing it in a puddled wall, to keep the character of the soil from changing. These foundations have partly failed, and serious cracks have appeared in different parts of the structure. We wish here to call your attention to the remarks which we shall make later on, upon judging of the supporting power of soils by limited experiments upon the same. We have not been able to find any complete account of how they were made in this case.

We find recorded by DEBAUVE, a case of founding upon a loose, watery sand, partaking somewhat of the nature of quicksand, in which the load per sq. ft. was 1.8 tons. The sand is described as being of a sirupy consistency, and after endeavoring to excavate it without success, further than getting out about 3 ft. in depth, they filled back into this partially excavated hole with dry, coarse sand, placed a bed of béton upon it, and completed the structure, which was a bridge over the canal of the Sambre a l'Oise, for the railroad from Busigny to Herson in France. No after settlement occurred.

This method of treating quicksands with coarser sands and gravel, appears to have been of much service in many cases. TRAUTWINE records an example of its successful use in making a foundation over quicksand, for the brick aqueduct for supplying Boston with water.

Supporting Power of Soft Soils.—In speaking of soft soils we generally mean those which are referred to as being compressible, though really this is more or less of a misnomer, for they are regarded as being the more compressible in proportion to the amount of water they hold, and yet we know that water is practically incompressible. DEBAUVE, in his excellent work on foundations, makes this distinction clear, and classes such soils as "*mobile*," moveable, which in itself is a true definition of their characteristics.

The alluvial mud of many rivers gives us the best example of soils of this kind, and in this country, as in general in most others, the soft soils are usually found at the lower end of rivers flowing through valleys of considerable width, and emptying into the sea or large lakes, where the force of their currents is checked by the larger body of water, causing the detritus held in suspension to be deposited in beds of greater or less thickness; or by overflowing their banks and spreading far and wide throughout the valley the waters lose sufficient velocity to carry the suspended matter further.

An example of the greatest magnitude of such formation, is seen in the country adjacent to the lower Mississippi, and much of the State of Louisiana has been formed in this way. Here is to be found the "*prairie tremblante*", or trembling prairie—vast stretches of land composed of semi-fluid, mud subsoil, overlaid by a mass of decayed vegetable matter, which, tied together by rootlets, forms a more solid, but trembling, crust.

It is impossible, of course, to solidly found anything upon such soil; but rather must any such attempt be regarded as a problem of flotation in a muddy liquid. Yet we are often called upon to construct railroads, bridges and buildings in soil but a trifle more solid and homogeneous.

The supporting power of all soils is of course dependent more or less upon the depth at which the foundation is made, and in the alluvial soils such as we are now considering, this is of more importance than in other kinds. We have not time at our disposal, in this paper to enter into this matter more fully, and in our remarks we have treated upon the

EXAMPLES OF FOUNDATIONS ON SOILS.

	Name of Structure.	Date.	Engineer.	Kind of soil under foundation.	Pressure per sq. ft. (tons of 2240 lbs.)	Remarks.
1	Central Viaduct, Cleveland, Ohio	1887	C. G. Force.	Blue clay.	1.0 to 1.7	The blue clay of the foundation is mixed with some sand and water. (Journal of Assn. of Engr. Soc., Vol. VI, No. 6.)
2	Bridge on R. R., Busigny to Herson, France	....	.....	Unstable sand.	1.8	Over the Canal de la Sambre. (Debauve.)
3	Arches on R.R., Busigny to Somain, France	....	.....	Yellow sandy clay.	2.1 to 2.8	(Debauve.)
4	Chimney at Newcastle-on-Tyne	....	R. Stevenson.	Compact clay.	1⅞	(Trans. Am. Soc. C. E., Vol. II., page 287.)
5	Kullenbourg Bridge, Holland	....	.....	Compact sand.	2.3 to 2.9	A slight mixture of clay with the sand. (Debauve.)
6	Chimney, N. Y. Steam Co.	1882	C. E. Emery.	Wet sand.	4.0	Sand was not very compact; some slight settlement. (Trans. Am. Soc. C. E., Vol. 14, p. 186.)
7	Viaduct, Point-du-Jour, Paris	....	Bassompierre Sewrin.	Coarse gravel.	4.4	(Debauve.)
8	Bridge, Auchorage	1882	Roebling.	Sand.	4.0	
9	Brklyn Bridge, N. Y. Pier	1882	"	Compact stony clay.	5.5	
10	Nantes Bridge, France	1863	.....	Sand.	6.78	Some settlement has taken place. (Gaudard.)
11	Goral Bridge, Lock Ken	....	.....	Compact sand and gravel.	7.36 to 8.17	(Gaudard.)
	Viaduct					
	Bridge		.....			
12	Washington Monument	1884	U. S. Engineers.	Clay and sand.	3 to 9	Slight settlement during construction. (H. R. Mis. Doc., No. 8, 48th Congr., 2nd session.)

[2] Trans. Am. Soc. C. E., Vol. 8.

[3] Trans. Am. Soc. C. E. Vol. 14.

supporting power of soils as we generally use them, and not much affected by depth.

The softer clays really belong to and should be treated in the same manner as the soft alluvial soils to which we are now alluding.

The actual supporting power of such soils can hardly be given in figures which can be of much real value. In the city of New Orleans, for instance, almost without exception, we find recorded the serious settlement of all the larger buildings and structures, which have been founded directly upon the alluvial soil, and in many cases the load per square foot is much less than a ton. From some experiments made in India in alluvial soil, the safe load per square foot is given as 1 ton; while Sir CHARLES FOX[4] finds it to be only 1,680 lbs. for the soil which he tested.

Experiments to determine the weight which can be safely placed upon soft soils have often been made, but are not generally of much value, unless the area of soil tested is of about the same extent as the base of the foundation to be placed upon it. This was very clearly shown in France, some years since, by a series of experiments made in the soft alluvial soil of the valleys of Vilane and l'Oust.[5]

A number of small piers of masonry, 6.56 ft. square, were built at different points, and made of such a height as to give a load per square centimeter double that of the large embankment, which it was the intention to afterwards construct. It was supposed that these piers would settle deep into the mud, but they really settled a comparatively small amount, while the embankment, covering a great, broad area of base, but exerting a pressure per square centimeter of only one-half that of the piers, showed in all cases very much greater settlements.

The explanation was simple: if a small pier, with a square base, pressed down into the soft soil, the frictional resistance against the sides of the compressed ground is proportional to the length of these sides while a square pier of, say, double the width, would experience a frictional resistance just twice that of the first pier. In other words, this resistance is directly proportionate to the *length* of the perimeters of the bases. But the *area* of the base of the second pier is four times that of the first, hence we see that, with an equal pressure per square unit of base, a small pier would have much more resistance to overcome than a large one, and that one would be at fault to take as a correct measurement of the supporting power of the soil the results obtained from loading but a limited area. Experiments upon the soil in New Orleans, made in 1851 and 1852, and which are recorded in *Van Nostrand's Magazine*, Vol. 27 showed analogous results.

Stated then as a proposition: *The supporting power of soft soils is greater in proportion as the loaded area is limited*, or, conversely; *large areas of soft soil will not support as much weight, per unit of surface, as more limited areas of the same soil.*

This principle is most important and should not be neglected by engineers designing foundations. It is applicable to the supporting power of bearing piles, and hence any formula for the same which does not make a distinction due to different sectional areas of the piles, is incorrect in theory.

The Honduras North Coast Railway.

A concession for a railway along the Atlantic coast from Truxillo to Puerto Cortez and the Guatemala frontier was granted by the Government of Honduras, Central America, in July, 1884, to W. ALLSTROM, an American, and is interesting as an important step toward the development of that backward region. The Honduras North Coast Railway & Improvement Co. was then organized in New Orleans, La., to build and operate the line, and the concession was transferred to this company, which is now about to proceed with the construction of the road.

The concession is for 99 years, with an exclusive right for 40 years; it gives a land grant of 9 square miles for each mile of line built, permits the importation of men and materials free of tax or duty and exempts the railway and its appurtenances from State or municipal taxes. Wharves, telegraph lines, etc., in connection with the railway, are also authorized. The company can name its own freight and passenger rates and will own all the receipts. The road is to be completed in July, 1889, but if it is not completed by that time the company will not lose its rights if it has built and has in operation sections of 50 miles in length from Truxillo and 25 miles from Puerto Cortez. At the end of 99 years the Government may purchase the railway at a valuation, or take possession and pay the company for its use, or it may extend the concession. The company has so far complied with all the conditions of the concession, but must have 75 miles in operation by July, 1889.

In the early part of 1885 a survey was made by Mr. ABRAM CUTLER, C. E., and work was started in July of that year, but was suspended until financial arrangements should be concluded for the completion of the line. The route was about 150 miles long, which was expected to be reduced to 135 miles by the final location. There was to be one tunnel about 300 ft. long, and a small amount of rock excavation on the 8½ miles where the line passed through the Farellones, or foot hills, but with these exceptions nearly all the work was to consist of earth embankments from 1 to 3 ft. in height. Several streams were crossed, including 5 rivers, one of which, the Ulua, is navigable for about 100 miles. The curves ranged from 955 ft. to 5,730 ft. radius, and the grades from 26.4 to 264 ft. per mile, about 75 per cent. of the entire line, as surveyed, being on the level. The intended gauge was 3 ft., and the total cost for the construction and equipment of a line of this gauge, with bridges, tunnel and works wide enough for a standard-gauge road, was estimated liberally at $1,542,881. Mr. CUTLER made a very favorable report, both as to the engineering work and the prospective traffic, and as to the advantages and probable development of the country.

In the Fall of 1887, a party of gentlemen interested in this road visited the Bridgeton & Saco River R. R., a line 16 miles long, in Maine, which has a gauge of 2 ft. and is constructed on the Mansfield system, with a view of adopting this system for the Honduras line. After investigating the operation of the road, together with its traffic arrangements,

Honduras North Coast Railway.

receipts, expenditures and general financial condition, it was decided to adopt this 2 ft. gauge, and a contract for construction has been awarded to Mr. GEO. E. MANSFIELD, of Boston, Mass., who will commence work at once, the operations being conducted by a construction company organized by Mr. MANSFIELD and associates.

The route passes through extensive forests of mahogany, cedar, iron wood and other valuable timber. The soil is rich and the entire coast country tributary to the railway, including the slopes of the Sierra Madre mountains, which are from 1 to 40 miles back from the coast, is open for development; it is well adaped for the cultivation of fruit, but as yet little attention has been paid to this, except for bananas, which form one of the principal items of export. There are 28 towns and settlements along the line, including the two terminal points, aggregating about 17,000 people, who are mostly engaged in the cultivation of fruit. The wages for labor average 62½ cts. per day. It is only within the last few years that facilities have been afforded for the traffic in fruit, but the annual importation of bananas at New Orleans has increased from 50,000 bunches in 1880 to 1,850,000 bunches in 1887. The railway is expected to aid materially in increasing the traffic by enabling vessels to load direct at the ports instead of at several points on the coast as at present.

The estimate of revenue and expense for the 3-ft. gauge road may be summarized as follows:

Total revenue		$544,000
Maintenance and operation	$180,000	
Sinking fund and interest on bonds	85 000	265,000
Balance		$279,000

The main difficulty in financiering the enterprise arose from the misapprehension and prejudice concerning Central America, but the matter seems now to be in good trim. Mr. S. B. MCCONNICO is President; Mr. J. JACKSON, Vice-President; and Mr. B. S. CHARLES, Secretary, of the Honduras North Coast Railway & Improvement Co.

The principal industry in which foreign capital is now invested in Honduras is that of mining, in which a number of American companies are interested.

The only railway now existing in the Republic is a line from Puerto Cortez to San Pedro, a distance of 38 miles. This forms part of a projected transisthmian line to the Bay of Fonseca, which line was abandoned. A few weeks ago, however, the Honduras Railway Co. was incorporated in London England, with a capital stock of $40,000,000, to complete this direct line. Another line projected by a New York syndicate, was to run from Truxillo to the Bay of Fonseca, following a circuitous route to accommodate a number of mining regions and having a branch to Tegucigalpa, the capital city. The North Coast Ry., however, will be the first line of any importance in operation, and will probably attract considerable attention to a part of the world of which comparatively little is known but which offers a wide field for development.

Berlin Electric Lamp Posts.

The *Centralblatt der Bauverwaltung* publishes the accompanying designs for electric lamp posts designed to be used in several important streets and parks of Berlin.—the famous "*Unter den Linden*", the "*Lustgarten*", and "*Kaiser Wilhelm*" Street—which are to be lighted by electricity. The

Fig. 1.

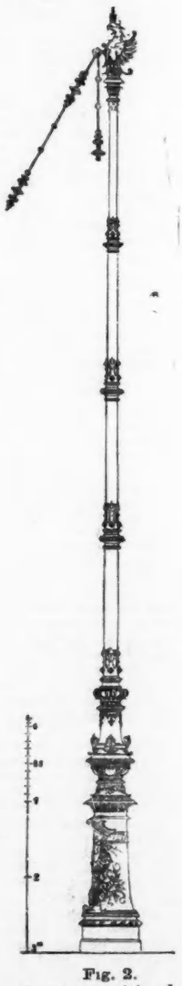


Fig. 2.

styles of posts were chosen from competitive designs, and will be generally admitted to be quite as handsome as any of those which adorn American streets.

Each post has a base of cast-iron, ornamented with symbolic designs. The shafts are of wrought-iron. Fig. 1 shows the kind adopted for use along the sidewalks. The lamp is hung in a funnel-shaped reflector which is rigidly connected with the post so as to prevent swaying. A chain running over a pulley connects the lamp with a counterweight in the hollow shaft.

[4] Cleemann's Railroad Engineer's Practice.
[5] Annales des Ponts et Chausées, 1864.

For lowering the lamp a somewhat clumsy device is used. The attendant is provided with a telescopic staff, which has a hooked end, with which he catches a ring beneath the globe and this draws it down within reach. The counterweight is made sufficiently heavy to raise the lamp to position again. The wires carrying the electric current run

A Berlin Electric Lamp Post.—Fig. 3.

from the lamp down to the middle of the shaft. The smaller posts are about 10 metres (33 ft.) high.

The larger ones are over 12 metres high. Fig. 2 shows an elevation of one of these, and Fig. 3 is a perspective view of the base. These are used on "*Unter den Linden*", which has a middle path, bordered by trees, for pedestrians.

In order to prevent heavy shadows from these trees, and at the same time to leave the path unobstructed, the lamp is suspended over the center of the footway from a chain connecting a pair of posts —one at each side of the walk. It is lowered as in the single posts, the counterweight being in the shaft on one side, and the wires on the other.

The price of the smaller posts was limited to 650 marks ($156) and for the double posts 1200 marks ($288); whether the cost of these is to be as high as that or not does not appear, but their great height and highly ornate character naturally tends to make them somewhat costly. It will be generally admitted, we think, that the designs are exceedingly graceful, and ought to make us in America a little ashamed of our own plain and often ugly lamp-posts.

The lights in all cases are to be 26¼ ft. above the ground and 134 ft. apart.

IN a lecture before the French Physical Society, M. VICTOR POPP stated that in Paris the pipe laid for the distribution of compressed air as a motive power for small factories, etc., already amounts to more than 30 miles. The engines at the central station have 3,000 horse-power, and compress about 3,000,000 cu. ft. of air per day to 80 lbs. per sq. in., with a daily consumption of 50 tons of coal.

The Abt System on the Bolan Railway.

The Abt rack railway system, which was strongly recommended by Government officials for the Bolan Railway, India, has been adversely criticised on account of the supposed results of recent comparative experiments made with Abt and ordinary heavy locomotives at Hirok, a summary of which tests we give herewith.

The Indian Engineer quotes the following from a contemporary, which, it is claimed, is calculated to convey a wrong impression of the working of the system:

"At a recent trial before Col. WALLACE, Director of the Northwestern Railway, we understand that the engine carried away a considerable portion of the central rack rail. The engine was, at the time, under the orders of Herr GEAF, the German expert. If the rack be torn away from the sleepers in the experimental green tree, what shall be done in the dry of war-scare working at night? The Bolan line gradient is severe, 1 in 25, we understand, but not more severe than some grades on parts of the recently opened Canadian Pacific, which are worked with ordinary heavy engines."

The statement that the engine carried away a part of the rack rail is said to be erroneous. What actually happened was that the locomotive was run upon the rack portion of the line, with the engine driving the pinions which engage with the rack running backward while the locomotive was running forward. The result was a severe shock, but owing to the construction of the Abt rack and locomotive no serious damage resulted, which shows that the so-called "intricate toy" is very hard to derange. The engine was reversed and then proceeded without difficulty. Col. WALLACE reported, after his preliminary examination of the system, that it worked satisfactorily, the engine loads being doubled while the fuel consumption remained normal, and the rack giving increased brake power and safety.

In the experiments made at Hirok the weights of the "L" class engines were not given. They entered the rising gradient with a speed of 15 miles per hour and thus had an advantage over the Abt locomotives, which began the ascent with a speed of only 4 or 5 miles per hour.

For purposes of comparison the pulling capacity of one type of heavy American locomotives is added. Two Consolidation engines, with cylinders 20×24 ins., will haul a load of from 350 to 386 tons up a 4 per cent. grade.

A SYSTEM of automatic telephone call boxes is in use in Glasgow, consisting of 76 boxes scattered about the city, to which subscribers have keys. When a non-subscriber wants to use the telephone, he first rings up the exchange and ascertains whether the desired connection can be made. If it can, the fee of 3 or 6 pennies, according to the distance he wants to talk, are dropped one by one into a hole in the box. The pennies, as they fall, break a circuit and ring a bell at the central station, and if the required number is announced the central office makes the connection. At the end of three minutes allowed for conversation the connection is automatically broken. The average time taken to put two persons in telephonic communication in Glasgow is 35 seconds, in Birmingham 40, in Liverpool 32, and Dundee 20. This was ascertained from the results of ten calls in each town.

Railways in Canada and the United States.

According to JOHNSON'S "Graphic Statistics" the year 1887 was a prosperous one for Canadian railways, and shows a decided increase of business over the preceding year. Some of the figures given are quoted and for purposes of comparison, a few facts concerning railways in the United States are added in what follows.

Miles of completed railway in Canada, June 30, 1887, 12,292. Miles of completed railway, United States, Dec. 31, 1887, 137,968. In Canada, in 1887, 16,367,987 tons of freight were moved, and 10,685,508 passengers were carried. Receipts from passenger traffic, $11,861,597; from freight traffic, $24,581,647. The receipts per trait mile were $1.15½, and the expenditure, 82½ cts., making the expense, 71.12 per cent. of the gross receipts. In the United States, in 1886, the receipts per train mile were a little less than 90 cts., and the expenses, about 56 cts., making the expenses 65.84 per cent. of the gross earnings.

Summary of Experiments of Abt and Heavy Class "L" Engines. Made by FRITZ A. GEAF, Abt Engineer at Hirok, March, 1888, on a section of the Bolan Railway 1 mile long, with a gradient of 4 per cent.

Engines.	Vehicles. Loaded.	Vehicles. Empty	Weight, tons.	Time, min. and secs.	Mil's per hour.	Remarks.
One Abt	8	2 B	158	7.30	8.0	Steam fell to 120 lbs.
"	9	4	186¾	Not noted.	.....	Too much steam wasted at starting; the train was taken up, but with stoppages on the way.
Two Abt	9	4	186¾	6.30	9.23	Steam kept even.
"	9	4	186¾	4.50	12.41	Steam kept well between 130 and 140 lbs.
"	9	13	269	10.0	6.0	Steam kept well.
"	9	17	304	10.0	6.0	Steam kept between 120 and 140 lbs.
2 Heavy "L" Class.	9	4	186¾	6.0	10.0	Steam kept very well.
2 "	10	6	221¼	6.35	9.1	Steam kept well 140-160 lbs. If stopped could not have started again.
2 "	11	8	259¼	9.10	6.55	Steam kept well, hard pull.
One Abt	11	8	259¼	5.0	4.0	The time taken was 19 minutes; a stoppage of 4 minutes was made to get up steam when half way; the gauge fell to 120 lbs. This load appears to be the maximum.

The number of passengers carried was equal to 2¼ for every inhabitant, and the freight amounted to 3.25 tons per inhabitant. United States, 1886, 382,284,972 passengers carried, and 482,245,254 tons of freight moved, or about 6 passengers and 8 tons of freight per inhabitant.

In Canada, the increase in railway business of 1887 over 1886, has been: Miles completed, 700; passengers carried, 824,474; tons carried, 697,527; receipts from all sources, $5,452,227; expenses, $3,447,601. There is an increase of receipts per train mile of 7 cts. and a slight decrease of expenses. The increase in traffic on the Intercolonial Railway was 130,000 tons of freight, and 50,000 passengers.

The advances made in the last ten years, are as follows:

In Canada, the miles completed have doubled; total passengers carried have increased 60 per cent, and the number per inhabitant, 40 per cent.; total freight increase, 107 per cent.; increase per inhabitant, 97 per cent.; receipts from all sources increased, about 90 per cent.; from passengers, 86 per cent.; and from freight, more than 86 per cent. The increase in expenses has been 72 per cent. In the United States the mileage has increased 90 per cent., or nearly double, in the last ten years.

THE cost of construction of gravel roads in Illinois has, according to Senator WASHBURN, been about $900 per mile, only $391.30 in excess of the ordinary dirt roads. The cost of maintenance is slight. Gravel roads, though not so durable as macadam, have proved to be very serviceable. On country highways the bed is usually made 12 ins. deep in the center, 9 ins. at the sides, and the road bed 12 ft. wide. In the State of Illinois the gravel deposits are generally found covered with about 10 ft. of soil, and the beds range from 7 ft. to 15 ft. in thickness. A cubic yard weighs about 3,200 lbs. When the distance is not greater than 1¾ miles one team will haul 7 cu. yds. per day. Even with hauls of 5 or 6 miles the work can be done at reasonable cost. Several hundred miles will probably be built in the next few years, and will add greatly to the comfort and convenience of local travellers.

BY the breakage of the booms on the Upper St. Louis river near Duluth, Minn., on June 13, more than 60,000,000 ft. of logs escaped down stream, resulting in a loss to the lumber companies of about a half million dollars.

Artesian Well in the Place Hebert, Paris.

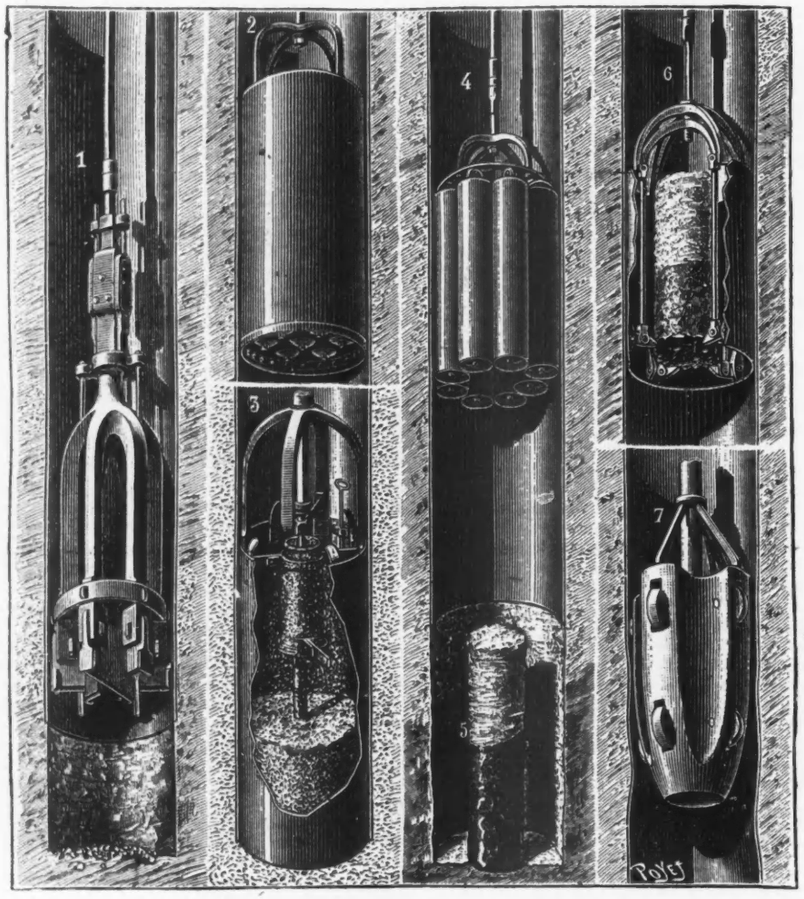
This new well, work on which has been in progress for a long time, has finally reached the water supply sought at a depth of 2,359 ft. We abstract from *La Nature* the following brief account of the work and the illustration of the drilling appliances given herewith.

The diameter of this well is 3½ ft., which is greatly in excess of similar wells in France which are usually from 4 ins. to 8 ins. in diameter. The drilling was done by the firm of LIPPMAN, Paris, and the work is now complete except for the reservoir for storing the water. At present the water is discharged into the city sewers.

The water, which lies in a strata between points 2,309 ft. and 2,362 ft. below the surface, is thought to come from Champagne. It is very pure, and its temperature is about 30° C. while water at the surface is usually at a temperature of 12° C.

Mr. LIPPMAN has a balanced shaft and the weighted drill has a free fall; that is, the blow is the result of gravity acting upon the weighted drill, which is released by a trigger when raised to a certain height By this arrangement the work of drilling is not increased as the depth of the well increases.

The accompanying illustration shows the cutting tools and lifting apparatus used. No 1 is the drill, 4 ft. 6 ins. in diameter, with six arms and a large transverse blade. This instrument is not only used for sinking the well, but for cutting out specimens, in which case the transverse blade is replaced by two smaller ones. No. 2 is a cylinder with 7 valves, for removing the material pulverized by the drill. No. 3 is a sand pump. No. 4 consists of 8 tubes with valves at the bottom, and is used to clean out the annular space left by drill No. 1 when cutting out a sample for removal. No. 5 is a specimen ready for removal by the clamps as shown in No. 6. No. 7 is a heavy tool provided with 8 rollers for straightening bent tubes, or for grinding up tubes that have been broken.



Instruments for Boring Artesian Well; Place Herbert, Paris.

Mr. LIPPMAN'S experience with artesian wells demonstrated that the strata lying above the one from which the water is to be taken should be shut off entirely from it, as the greatest supply and highest pressure is generally found at the greatest depth, and the ascensional force of the water in a stratum will be diminished if there is communication with a supply under a lower pressure. At the Tours wells three upper water-bearing strata were traversed, the water being drawn from the fourth at a depth of 558 ft. A well in which the lower strata was isolated from the others gave a discharge at the surface of 1,056 galls. per minute, while another well of precisely the same diameter and level, but communicating with the upper strata, only discharged 264 galls. per minute.

The methods of boring used for wells of small diameter,—the Chinese method, boring with a hollow instrument, and LESCHOT'S method of boring with black diamonds,—are not used for wells of more than one foot in diameter, but a very powerful rigid instrument is employed, The apparatus used by

The tubing is made in sections from 3 ft. to 12 ft. long, and varies in thickness from 0.118 in. to 0.787 in. The sections are so riveted that they form a continuous casing from top to bottom, with smooth interior in which the drill works without unnecessary jar or friction. The weight of the drills used at the Place Hebert was 8,000 lbs., but at Konigsborn and Gelsenkirchen drills were used weighing 50,000 lbs. The fall is from 1 ft. to 1 ft. 6 ins. and from 10 to 15 strokes are made per minute, depending on the height of the lift.

One of the most frequently occurring accidents is the crushing or displacing of sections of tubing at great depths. The removal of these broken tubes is a very slow and difficult task.

Dynamite is sometimes used to break formations impenetrable by the drill, but its action is not effective under the conditions existing, and it sometimes simply lifts the column of water, which immediately falls back again.

At the Place Hebert the water spouts 114 ft. high. Reservoirs will soon be constructed, from which the water will be distributed to factories and perhaps to private houses.

The Water Supply of the Panama Canal.

Le Génie Civil, in its issue of May 19, publishes a somewhat remarkable article in regard to the water supply of the Panama canal under the new lock system, the substance of which we reproduce below. The article is not given as official, but it appears from internal evidence to be put forth as an official and inspired statement of the plans for the new works, since many of the data could only have been obtained from the company. In connection with the other matter relating to the canal, which we have already published and publish this week, it will be seen to have a very interesting bearing on the status of the work. *Le Génie Civil* says:

We have discussed in previous articles, the studies for the work of the Panama canal as it has been finally decided to build it, including as a maximum, 5 locks on each side of the divide. It will now be well to study the question of the water supply of the canal under this plan. The water surface of the summit level will be at + 49 metres, and the following table indicates the exact arrangement of the locks.

TABLE I. LOCK SYSTEM OF PANAMA CANAL.

No. of Lock and Level.	Lift of Lock.	Water Level.	Location of Lock. Kilos.	Length of each Level Kilos.
Sea Level.	M.	0.	0.	
1	8.	8.	22.750	22.750
2	8.	16.	37.156	14.406
3	11.	27.	43.855	6.699
4	11.	38.	46.250	2.395
5	11.	49.	50.460	4.210
6	11.	38.	55.560	5.100
7	11.	27.	56.900	1.340
8	11.	16.	57.790	0.890
9	8.	8.	59.100	1.310
				2.740
10	11.	0 to −3.	61.840	12.660
Total length, Kilos.				74.500.

The mean level of the sea is sensibly the same at each end of the canal. Lock 10 varies in lift from 5 to 11 metres, according to the stage of the tide.

The question of the mere control of the water supply, the main one in the beginning, has become enlarged under new conditions into one of feeding successive lock levels. TI is great problem for the skill of the engineer, has been studied by the aid of exact data as to the regimen of the water supply of the region, which admit of prec se calculations, as we will summarize.

The summit level will require (1) the water needed for navigation, (2) the water needed to make good the leakage through the locks by evaporation and filtration, accidents, mistakes and wrong handling of vessels, etc.

Water Supply for Navigation.—10 lockages in 24 hours will correspond to a traffic of 7,500,000 tons, assuming the vessels to go in convoys, in a single track canal, with single locks. The volume per lock is calculated on the basis of greatest lift, 11 metres, and will require [We omit the details. ED.] for regular convoys, a consumption of water in 24 hours of 20 + 42,206.65 = 844,139 cu. m., or per second 9.77 cu. m.: in round numbers 10 cu. m. of water per second. For exceptional passages of single ships, we must add per second 5 cu. m. to this total.

Losses by Evaporation and Filtration.—The river channels and other waters near the canal will compensate in part for these losses on the two lower levels. Again, the lock lifts of those levels are only eight-elevenths of the lock lifts of the upper locks; hence three-elevenths of the whole volume of water will be available to make up for losses on these lower levels. Between lock No. 3 and lock No. 8, will be a length of 13.935 kilometers, and we may assume for them a loss by evaporation of .007 m., per day (0.28 ins.) or in round numbers, 300 cu. m. per kilometer.

The loss by filtration cannot be exactly calculated. It will be a large estimate to assume 10,000 cu. m. per kilometer per day; or for the whole distance of 11.935 kilometers below the summit level, 143,531 cu. m., equal to about a flow of 1.661 cu. m. per second.

Losses Through Gates.—This applies only to the summit level, the losses of the lower lock levels being compensatory. We may assume 1 cu. m. per second per gate, or 2 cu. m. per second in all.

For Accidents and Contingences, we may allow about 15 per cent of the entire water supply, otherwise required. These losses will be certainly small under the necessarily very watchful management.

To summarize, the total necessary supply of water is as follows:

	cu. m. per sec.
For navigation, with regular convoys	10.000
For evaporation and filtration	1.661
For losses through gates	2.000
For water supply for exceptional traffic, losses by accidents and contingences, etc.	2.339
Total	16.000

When occasion requires exceptional traffic of ships not in convoys, this total will be raised to 21 cu. m. per second.

The sources of supply.—These are the waters of the Chagres, of the Obispo and of the Rio Grande. The area of the basin of the Chagres above the junction of the Obispo, where it first touches the canal is 180,000 hectares: annual rainfall 2.50 metres (98½ ins). The flow of the Chagres, as deduced from the records of the fluviograph at Gamboa, are as shown in Table II. for the years 1883, 1884, 1885 and 1886.

TABLE II.—MINIMUM, AVERAGE, AND MAXIMUM FLOW OF THE CHAGRES RIVER, IN CUBIC METRES PER SECOND, AS REGISTERED BY THE FLUVIOGRAPH AT GAMBOA.

[Estimated minimum supply required, 16 cu.m. per sec.]

A. MINIMUM FLOW IN EACH MONTH, cu. m. per sec.

	1883	1884	1885	1886
January	12.0	20.0	29.0	54.0
February	18.0	24.0	29.0	49.0
March	14.0	20.0	26.0	36.0
April	10.0	16.0	15.0	36.0
May	35.0	44.0	18.0	44.0
June	35.0	57.0	32.0	55.0
July	42.0	41.5	43.0	66.0
August	58.0	44.0	80.0	76.0
September	46.0	46.0	95.0	74.0
October	54.0	45.0	95.0	128.0
November	44.0	44.0	85.0	136.0
December	50.0	43.0	112.0	80.0

B. MEAN FLOW PER MONTH, cu. m. per sec.

January	34.8	38.9	40.4	83.5
February	18.5	26.6	33.4	62.2
March	13.8	21.6	30.2	57.8
April	12.6	34.8	25.1	39.8
May	53.1	100.0	35.4	76.2
June	65.8	150.2	60.1	96.8
July	97.8	118.5	123.2	108.5
August	133.2	81.6	166.8	133.2
September	122.2	99.2	170.8	140.6
October	114.6	103.8	168.8	199.1
November	81.5	105.4	199.1	282.2
December	103.8	69.8	214.5	175.8
Mean	71.0	79.2	105.6	121.3

C. MAXIMUM FLOW IN EACH MONTH, cu. m. per sec.

January	168.0	104.0	41.0	165.0
February	22.0	40.0	34.0	75.0
March	17.0	24.0	31.0	460.0
April	36.0	450.0	49.0	211.0
May	650.0	450.0	112.0	278.0
June	520.0	690.0	315.0	300.0
July	650.0	703.0	642.0	325.0
August	520.0	580.0	723.0	411.0
September	520.0	525.0	742.0	560.0
October	328.0	603.0	405.0	622.0
November	420.0	782.0	1336.0	682.0
December	580.0	135.0	1003.0	610.0

[The highest recorded flood of the Chagres was by Col. TOTTEN, in 1857, 1 600 cu. m. per sec., or at the enormous rate of 36,495,360,000 U.S. galls. per day of 24 hours. Nov. 25, 1885, the discharge reported by Lieu. KIMBALL, (Report to Bureau of Navigation, 1886,) was 954 cu. m. per sec. The water rose 4 m. above its low stage in 12 hours, 1.4 m. more in the next 12 hours, 2.6 m. more in the next 12 (8.02 m. in all), and fell in the next 12 hours + to its low stage. At its highest stage the water was 30 ft. (9 m.) deep, and 1,600 ft. (480 m. across, giving a sectional area of some 2,160 sq. m.—ED. ENG. NEWS.]

The aggregate discharge of the Obispo and Rio Grande, which can be fed by gravity to the upper level, is about one-twelfth of that of the Chagres, thus falling at times to 1 c. m. per sec.

[Certain remarkable features of this table demand a word of comment. The first is that there are no records running back of 1883, when the work was determined on in 1879 and started early in 1881, the Chagres being admitted to be the most serious indeterminate element. The second is the remarkable contrast between the discharge in the earlier years, when the sea-level project was on foot, and 1886 when the lock system had been determined on. It is certainly fortunate that the minimum water supply has become so much more abundant lately, now that it has become an important element in the problem of operating a lock canal, but the figures for 1883 make it doubtful whether in such a year the canal could be operated at all during the dryer months.—ED. ENG. NEWS.]

From this table we may conclude, that in the average year, the annual flow will not be less than 28 metres per second. It reaches 36 metres in rainy years.

For the Obispo and Rio Grande no direct observations have been made, but they may be deduced from the Chagres records by a simple calculation, assuming the discharge of each to be proportional to the respective water sheds; and by computations on this basis we find that these two streams together will furnish in average years an average supply of about 9 metres per second, and almost 7 meters in dry years: but this flow may fall to about 1 metre. The Obispo and the upper Rio Grande are the only streams whose waters can be carried to the summit level by natural flow. As we have seen, 16 cu. m. per second must be supplied to the summit level. As the total flow of the Obispo and Rio Grande may fall at time of low water to a single cubic metre only, it need not be taken into account.

The Supply of the Summit Level.—Four methods are possible:

(1) By a feeder canal heading in the upper Chagres valley.

(2) By a dam at Gamboa, raising the water surface of Chagres to at least + 50 level.

(3) By pumping up the water of the Chagres at their natural low stage into a feeder above the level + 49.

(4) By a mixed system of natural water supply and pumping.

We may analyze these separate possibilities as follows:

Feeder from the Upper Chagres.—This would be, at first sight, a complete solution of the problem, but it would require, according to the typographical studies, a feeding canal 32.4 kilometers long, (20 miles) which would be a veritable "canal annex" (the French literally translates into the slang of the day,) tedious and costly to construct. This plan is weakest as respects securing the water, for it would demand as a feature, in order to secure a sufficient reserve of water, the construction of a great dam, 20 meters high. For all these reasons, the plan should be discarded.

Dam at Gamboa.—The construction of a great dam at Gamboa has been proposed from the first, and in the deep valley between the hills Obispo and Santa Cruz is an excellent site for its construction. As a feature of the sea level canal, the dam had in view the control of the water and the regulation of its flow. Its crest needed to be at the level of + 70 metres above the sea and its weir waste level at about + 65.

When the study of the lock plan succeeded to the first idea of merely controlling the water, it was natural to think of utilizing for the water supply the reserve which would be created by such a dam. This project has not seemed expedient to adhere to for these reasons: In the first place the deviation of river channels required by the dam on the Atlantic slope would require 58 kilometers of dikes, and 9,000,000 cu. m. of embankment; that is to say, considerable works. In the next place, another important matter, the lock plan has reduced to an enormous extent the excavation remaining to be done, down to the level + 40. It is precisely this reduction of work which has been sought by the use of locks, but the construction of a great dam at Gamboa, such as was originally proposed, would require the execution of an enormous volume of material. Now, the cube remaining to be taken out above level + 40, which would serve for the construction of the dam, would not suffice to build it [This amazing statement we quote literally. ED.] with proper dimensions to ensure its strength and security.

Mechanical Elevation of Water Supply.—We may now consider the plan of lifting water mechanically, by taking it from the Chagres at its low level, and supplying it to a feeder diteh leading to a summit level at + 49 meters. This plan is evidently practicable; there are a number of canals supplied by steam or water pumps; for example, the canal from the Aisne to the Marne; that from the Marne to the Rhine, etc.

The canal now building from Liverpool to Manchester along the banks of the Mersey will probably resort to mechanical water supply, also the Oder-Spree canal in Germany.

In the special case of the upper level of the Panama canal, mechanical supply is easy, and the expense which it will involve, moderate. It will not exceed, according to exact estimate, $4,000,000 for the plant.

The annual expense of maintenance and operation will be in the neighborhood of $1,200,000. On the other hand, when we consider the possibility of the ultimate dropping of the canal to sea-level, we must foresee the expense for the quantity of water necessary to transport dredgings, increasing in proportion as the canal is deepened. With a purely artificial water supply it will be necessary to include for this a new expenditure almost equal to the first mentioned, which would greatly burden the operation of the canal. A purely mechanical water supply, therefore, will not correspond to economic conditions.

By combining the two means of natural and artificial supply we shall obtain the minimum expense.

Combined Natural and Artificial Supply.—There is no necessity, it is apparent, for pumping the waters of the Chagres from their low stage, that is to say, about + 15 m. above sea. It is easy to conceive of the natural storage of the water up to a level about that of the lock at elevation + 27. From this point we may begin the artificial supply, properly so called. This requires the construction of a reservoir dam, near the point originally proposed for the large Gamboa dam, which should stop, according to the topographical conditions, at about the level + 30. To secure this economical and advantageous end it is necessary to construct a dam which shall be tight, and shall not be subject to seepage, under or through it. Similar works, of earlier date, as notably in Algeria, show that it is entirely possible to utilize earthwork from excavations only for the construction of reservoir dams. The Gamboa dam will be so constructed, practically the whole of its volume being from spoil taken from the excavations near, and from the material removed from the Obispo-Emperador section, of which the cubic contents will be about 4,000,000 metres. To carry this dam up to level 45 m., and use all this material, would give, at the crest, a width of 250 meters, and would offer very little gain in dimensions from the great dam originally proposed in 1883.

Under the new plan, with the water level at about elevation + 27, the pressure of the water behind the dam, at a maximum of 15 m. depth, will be greater by 4 meters only than that which the great lock gates sustain. Two objections may be made to this plan, leaking or soakage, and tightness.

Leaking and Soakage.—The most serious objection appears to be the possible leaking and soakage through the bed of sand in the Chagres, which, under the plan adopted, will not be entirely removed. This leaking, if it occurs, will be, chiefly, soon after construction. Under these conditions it will have no other effect than to contribute to the general solidity of the work by the consolidation of the mass which it will promote, and it is precisely this effect which it is desired to secure as rapidly as possible.

Choking by Mud.—We may say that this is a constitutional defect of dams. It has been the worst foe of our Algerian dam builders, as also of engineers in Spain, where from the earliest ages it has puzzled their skill. Now, in the special case of the Chagres, as a result of the exceptional geographical conditions of the soil, such choking need not be feared.

M. DINGLER, the learned director of the works of the company, in a special report on the waters of the Chagres, makes this clear. The waters when muddy carry in suspension, not over 40 grammes per cubic meter; when clear, they carry 10 grammes. The Chagres discharges annually 2,000 million c. m.; hence, the deposit will be about 33,000 c. m. per year. These figures are too trifling for consideration in comparison with the volume of the water channels and reservoirs. Nothing need be added for further discussion to these figures, resulting from careful and conclusive experiments.

There remains the question of tightness.

Will the dam be tight? The response does not seem to be doubtful. Tightness necessarily results from the geological nature of the material, which is used to construct the dam. In fact, we may say that from the technical point of the view the case has been already decided. A very careful investigation was had on this subject in 1883 and 1884, by the Superior Commission, when they were discussing the question of the great storage dam. The report presented by Inspector-General VOISIN-BAY, Engineer in Chief *Ponts et Chaussés*, is conclusive as to tightness.

Conclusion.—It appears from all the preceding, that it is possible and practical to procure a constant water supply on the lock canal, by mixed natural and artificial means, with a reservoir at a level about + 30. This dam will also serve at the same time to control the water and floods, and thus enter into the general plan otherwise. The price of .224 cts. per cubic meter will cover that of pumping, under the most unfavorable conditions.

[This price amounts to about 1 ct. per 1,000 gallons. The cost of pumping in Chicago, in 1887, was about 0.45 ct. per 1,000 galls, and 6.67 ct. in 1879, coal being $3.10 and $5.22 per ton respectively, and the average head 97 ft. ED.]

But it goes without saying, that the constructors will not feel obliged to confine themselves to the certain but costly process of pumping only. It has been suggested, for example, to avail of the resources of science to transport electric energy to a distance. It would be rash to assume that the recent progress of mechanical skill and of electric science would not enable the canal to feed and light itself by aid of artificial falls, created by its main reservoir and locks. However, this may be, the question of supply is nothing new or different for the art of the engineer. It is well to be exact on this point, since it is evidently an essential condition to the use of the lock canal.

THE Directors of the Utah Central Railway, a part of the Union Pacific system, have voted to build the proposed extension to the Nevada State line. It is intended eventually to build to Los Angeles, Cal.

The Nicaragua Canal Surveys.

Four members of the Nicaragua Canal surveying expedition reached this city on Tuesday. F. W. BENNETT, of Cape May, N. J.; BENJ. W. BATES, of Cambridge, Mass.; LOUIS W. MOHUN, and H. M. JOHNSON, of Washington, D. C. They bring advices from the surveys to May 20, and are just from the western division, to which they were transferred a few weeks ago, after completing their work on the San Juan river. They state that of the two large parties of which they formed a part, not one man has been absent from duty for a single day on account of sickness, for three months past. The entire expedition enjoyed excellent health, and all are reported happy over the results of their work.

The hydrographic party completed the off-shore soundings at Brito and the work in the Lake at the mouth of the Lajas river, and left for the San Juan about the middle of May. After a few days' work at San Carlos, the party were to proceed to Greytown, to finish the survey of the harbor.

Chief Engineer MENOCAL arrived from the east side before the hydrographic party left. He also examined the preliminary surveys of the line between the Lake and the Pacific, made by the parties under Mr. PEREZ and Mr. HOLCOMB, and made some alterations in the suggestions for the final location. This,it is said,will not vary materially from the line laid down by Mr. MENOCAL in 1880, but such alterations as are made are said to render it somewhat more favorable. We await more definite reports with interest.

The port of Brito,on the Pacific, is to extend 3,000 ft. inland from the coast line, by an enlarged canal and to be of about the same dimensions as proposed in the report of the U. S. Government Survey of 1885, with possible lateral enlargement, if required. The distance from the port to Lake Nicaragua by the axis of the canal is 16.97 miles. The elevation of the western summit "divide" is 152 ft. above the mean sea level, and the maximum cut 42 ft. above the level of the lake.

The practicability of converting a portion of the valley of the Rio Grande into a navigable basin is reported to be fully established. The slack-water part of this summit level will be 3.8 miles longer than has been heretofore proposed, with a corresponding reduction in the length of the canal sections.

On May 16, Mr. MENOCAL visited Managua and spent two days there, paying his respects to the President and cabinet. The President is stated to have expressed his great satisfaction at the manner in which the stipulations of the concession were being fulfilled, and declared that his government was anxious to render all possible assistance in the prosecution of the work.

On the completion of his visit to Managua Mr. MENOCAL left the west side to return to the head quarters of the survey on the San Juan river.

CORRESPONDENCE.

A Dubious Dam.

NEW BRUNSWICK, N. J., June 2, 1888.

EDITOR ENGINEERING NEWS:—

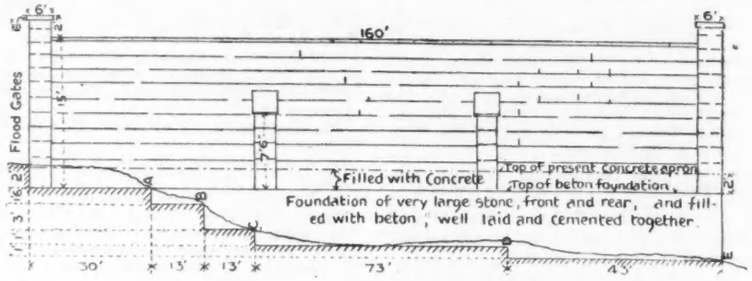
I send herewith one of the blue prints of the design of the New Brunswick Water-Works dam, on which bids were invited, and which it is now proposed to build. I also send a cross section of the dam at the highest part, with pressures and resultants shown to the nearest 100 lbs., when the dam is acting as a weir. The data are as follows:

Character of bottom unknown, except that it is some kind of rock with clay above it.

Highest flood known above crest of old dam, 300 ft.

Ice in pond at time of spring freshets, 10 to 16 ins. thick, but generally more or less rotten.

Pond behind dam about 2 miles long and narrow.



Dam at New Brunswick, N. J.: Elevation.

Stone to be trap, or sandstone, according to the bid, (no weight or kind was specified).

Old apron concrete still remaining; may go down to rock and may not.

Assumed weight of masonry, 150 lbs. per cu. ft.

" " beton 125 " "

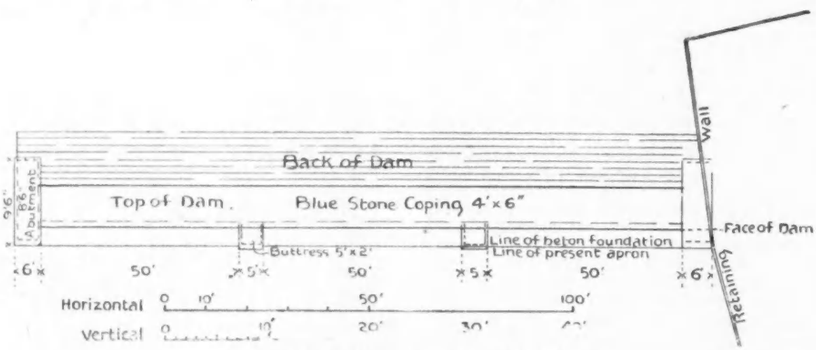
" " water 62.5 " "

Assumed water as standing at level of highest flood, and to be fair, the velocity effect has been left out, although it should have been included to add to the hyrostatic pressure.

In computing I found two formulæ in Prof. BOWSER'S "Hydromechanics" of considerable assistance, and give them here, as they may help others, as they are very compact:

Amount of horizontal pressure = area of projection of surface on a vertical plane × depth of center of gravity of surface below surface of water × weight cubic foot water. The point of application of pressure $= \frac{3}{8}\frac{a^3 - b^3}{a^2 - b^2}$ in which a = depth of bottom of dam below surface of water, and b = depth of top of dam below surface of water, both applying to pressures on immersed sections. In view of all that ENGINEERING NEWS has published in the past five months on dams, particularly Mr. FRANCIS' experiments in your issue of 19th inst., this design strikes me as being very ridiculous, to say the least.

Yours truly, GEO. HILL.



Dam at New Brunswick, N. J.: Plan.

[If our correspondent's drawings and diagrams are correct, which we see no reason to doubt, although we have not checked them over, it would be just as well to think twice before building this dam. We think we could guess the origin of this design, but, while it might stand all right, it is extremely liable not to, and can hardly be called a well-proportioned structure.—ED. ENG. NEWS.]

What the Slaven Dredges are Doing at Panama.

EDITOR ENGINEERING NEWS:

To get a good idea of the work that has been done on the Panama Canal one should pass a day or two with the Slaven dredges. These huge engines of peace, seven in number, have now been for several years quietly and steadily digging their way some 15 miles from the Atlantic end of the canal into the heart of the American isthmus. They were built, some at Philadelphia and some at Williamsburg, under the direction of the late Mr. M. A. SLAVEN, in honor of whom one is named. Their task has been to open the canal itself, and also to make the deviations, or cuts, which are intended to keep the water of the river Chagres out of the canal on either side, and to prevent any overflow. Some of them, at times, dig into a rocky bed of such toughness that it would scarcely be imagined they could cut through it, and now and then a large stone,or a piece of rock, comes up in one of the buckets, which has to be broken before it can safely be allowed to pass through the long discharge pipe. Others may be seen eating their way into a bank 15 ft. or more in height, so that, actually, they are excavators as well as dredges. Explosions of dynamite or powder at times have to be made under the water, as at Hell Gate, on a small scale, to loosen the hard bed of the canal before it can be lifted up.

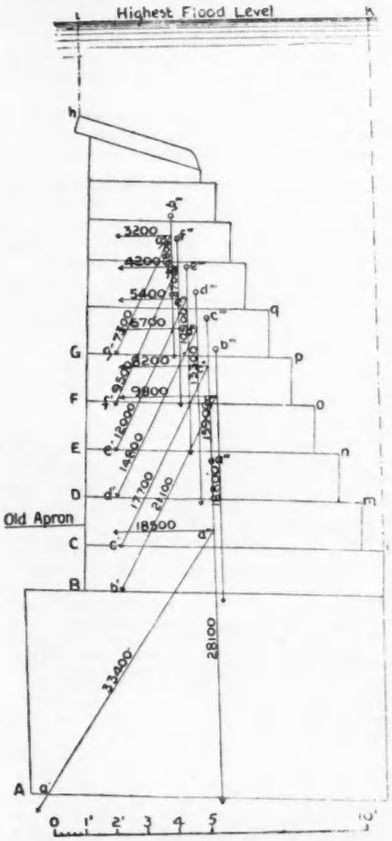
About a year and a half ago, at the time of the overflow of the Chagres, one of the dredges was carried off its course, and then, as the waters receded, found itself high and dry. How to get it afloat again taxed, for a long time, the ingenuity of Commodore SLAVEN'S representatives on the isthmus, but at length their native American cleverness helped them out of the scrape. A dam was built below the dredge, and an artificial pond was soon formed by pumping into it the water of the Chagres. A splendid Belgian pump, which had been imported by the canal company for some other work, and which happened to be idle, was secured, and right well did it accomplish its new job. This accident was a lucky one for the canal, for it caused a new departure in dredging, which is successfully carried on in various places along the line. These dams can now be quickly constructed,and at no very great expense, and when a dredge is working behind one, at an elevation above the sea level, one can easily see that it can discharge from the pipes over a much higher bank than would otherwise be possible. The ladders of the dredges, up which the buckets climb, have been so lengthened that there is no difficulty in their digging down to the required depth of nearly 30 ft. When the work is done the dam is removed by degrees, the water let out of it, and another link of completed canal is added to that already finished.

These dredges are in reality a combination in one of the two systems invented for the Suez canal. That is to say, after the buckets reach the top of the towers, instead of throwing their contents into a long chute, which was built on a float to follow alongside of the dredge, they have the chute, or discharge pipe, constructed as part of the dredge itself, which very much simplifies the operation. It is all one piece, and can throw the discharge well over the high banks, (for the towers of some of the dredges are about 80 ft. above the water) and for more than 100 ft. beyond the water's edge.

There is a singular fascination in watching one of these huge dredges at work, and so I invite you to make an imaginary trip with me. We can take the "Freddie-Ella," President H. B. SLAVEN'S pretty little steam yacht, at the entrance of the canal, and go in it, passing through the Mindi cut, which so long was a barrier to the canal, leaving behind us the "City of New York," digging,near Kilometre 11, the canal to its full depth, and so on up to the first dam, over which we walk and then take another boat, this time one rowed by Jamaica negroes, until over a second dam we come to the dredge "Dingler," named after the man who for several years was the energetic Director General of the Canal Co., and is now a member of the advisory committee at the

Paris office. Or we can go by train to Gatun, and there take the yacht, and before visiting the dredge make a stop at the workshop of "the American Contracting & Dredging Co." The burned dredge "Prosper Huerne" serves as a storeship in the Chagres river, and just behind it on the banks, in what a short time ago was an impenetrable tropical forest, we find a big trip hammer under a shed, a foundry and a shop full of machines adapted for all sorts of purposes needed in the repair of the dredges. We meet there Yankee mechanics using Yankee tools with men from other countries, with negroes to do the harder manual work.

The boilers and engines of the Slaven dredges are big specimens of motive power. Having seen them, let us go forward and see the buckets cut into the



Dam at New Brunswick, N. J.; Section.

soil in front of them. They are 39 in number, and climb up the ladder, as I saw them, at the rate of 28 a minute, full of rich clay or mud, which well shows the truth of the old expression "rich as mud", for a single day's work represents a goodly sum of money. Up they come with clocklike regularity, mounting to the tip of the tower, where with another almost automatic movement, or series of movements, they turn a somersault, and in so doing throw their contents into the great discharge pipe, which takes it well over the banks, where it drops down a huge mass of dark yellow looking soup. Below the chute is a man who has charge of the buckets, his work being to regulate the progress of the dredge in its different movements. The great "spuds" or anchor piles put themselves alternately down to the bottom of the canal bed, and so move the dredge along, swinging from side to side as it eats its way into the bank to the right or left of the axis of the canal. On the banks are the "gipsy" lines, which also keep the dredge in place as she advances. There, too, is the improvised fence to mark the line over which the discharge is to be made, and before you are the stakes, put in by an employé of the canal company to show the captain just how he is to go ahead.

We are now beyond Kilometer 20, not far from Bohio Soldado, and can see the beginning of the first lock in the distance, and here just now several of the dredges are congregated.

After a hearty and excellent meal on one of the dredges, I thought it would be interesting to know how much progress had been made in the cana during the hour that we were quietly enjoying our lunch, and I asked the captain and others present to give their views. The result of it was, from an easy calculation, that the dredge had taken up and discharged at least 1,000 cu. yds., and to do this had advanced about 15 ft, digging the canal to a width of 150 ft., while of course the depth was regulated by the length of the ladder. Such work as this is tremendous, and if it could continue without interruption, night and day, would soon complete the desired ditch; but naturally there are many interruptions from different causes, for instance a tree trunk which has been buried for years in the soil, and has to be removed with great care. If a dredge can take up 10,000 or 12,000 cu. yds. in twenty-four hours as they have occasionally done, it is a wonderful result.

As we were just finishing lunch, I heard some sort of noise, and I almost thought for a moment that a man was overboard. But no, it was merely one of the great iron links, that connect the buckets together, which had suddenly snapped, an accident that very rarely happens. The machinery was stopped at once, the link brought where it could be got at, and it was taken out and another one put in its place and riveted. All this was accomplished with a delay of about twenty minutes, when dredging went on as before.

On our way back, we took a short cut across the country in a very novel manner, by riding on the little Decauville cars, which were used by Mr. SLAVEN'S company to transport coal from a temporary station on the river to where it might be needed for the dredges or pumps on the canal or excavations. A plank was put on the car to serve as a seat, and with one or two strong negroes to push we soon got over the kilometer which we had to traverse.

It is interesting to notice how compact the banks of the canal soon become from the luxuriant tropical vegetation which grows over them, and forms a solid network. They may have their slopes laid out with all the precision of engineering science, but nature forms the inclination, which is almost more nearly vertical than would be considered practicable. A few weeks after the dredge has passed by, the banks are so covered with verdure that one can scarcely find a trace of the clay or mud which has been deposited on the banks, so transformed are they into green. Occasionally there will be a land slide from the looseness of the soil for a short distance, but then the dredge comes back some weeks or months later to repair the dumps, and a few hours work will set everything straight.

During the few days I was on the Isthmus, I saw or visited all of these seven American dredges. First, the "Count de Lesseps," cutting through a very hard rock deposit in the deviation which will be the Atlantic outlet of the Chagres below Colon or Aspinwall; then the one that bears my name, and which was still in the "Appleton cut", as it is called, where it has been working for a long while most successfully. At times it has been imprisoned for months in holes, which seemed to have no bottoms, as the material dredged would tumble back as fast as taken out. But victory crowned its efforts, and joined the long cut above and below. Gatun is well nigh finished, and the "De Lesseps" and the "Appleton" can soon shake hands, as those for whom the dredges are named have so often done. The "H. B. Slaven", the "Dingler", the "City of New York", and the "City of Paris" were all "up to their knees" in mud, which means business. The only one for the time idle, awaiting some reparation, was the "M. A. Slaven" and as we passed it, with uncovered heads and moistened eyes, we thought of the man whose task in this world is finished, to whose genius, energy and patience the building of this wonderful machine is principally due. As I looked at the dredge I said to President H. B. SLAVEN, "Ah, how happy your brother would be were he with us to-day, and could see the dredges work as we do."

There remains but little space in this article to speak of the other work that is being done upon the canal. Suffice it to say that six of the locks, of which there are to be eight and perhaps ten, are already well under way. They can be likened to great iron boxes with sliding doors, and are the invention of Mr. EIFFEL (who is putting up the high tower for the Paris Exhibition of 1889) and M. BUNAU-VARILLA, at one time acting Director General of the canal works, and now with Messrs. ARTIGUES and SONDEREGGER in charge of the deep cutting at Culebra. These locks are intended to be but a temporary expedient to enable the canal to be opened sooner and at less expense than would otherwise be possible; but all the same it is the intention of M. DE LESSEPS to have them removed as soon as can be done from the earnings of the canal so that his original plan of a tide level canal shall be realized. This plan of locks lessens the work of excavating by about 40,000,000 cu. yds., so that in reality there remains comparatively little to be done. A few more years of labor will doubtless see DE LESSEPS with the laurel of Panama added to that of Suez, and there could be no more fitting way of celebrating the four hundredth anniversary of Columbus' visit of discovery than a procession of ships of all nations through the canal which will pierce the isthmus in the United States of Columbia.

NATHAN APPLETON.

[We may appropriately subjoin to Mr. APPLETON'S letter some extracts from the last issue of *Harper's Weekly* giving further details of the dredges, and written from the same attitude toward the Canal Co. M. DE LESSEPS is now 83 years old. There is no more extraordinary evidence of the power of a great name and of an intense personality than that he should be able at his age to inspire such confidence in his assertions—such as those of latest date which we reprint elsewhere—as to lead men like MR. NATHAN APPLETON and papers like *Harper's Weekly* to accept and repeat them. ED. ENG. NEWS.]

The views along the line of the interoceanic ship-canal between Colon and Panama give a fair idea of what has been done with the $175,000,000 already spent in this gigantic enterprise. What remains to be done with the $35,000,000 working capital now in the treasury of the canal company, and with the proceeds of the loan of $70,000,000 just authorized by the French Chamber of Deputies—and which it seems likely the Government will finally sanction—may be readily inferred from the pictures.

With this and, the new lottery loan, experienced engineers declare the canal can actually be finished, by the EIFFEL lock system, before 1893. If this idea be anything like correct, there must be on the isthmus something more than a paper ditch.

About 18 miles of the canal from Colon southwestward are now open to navigation for vessels of *twelve feet draught*—[Italics ours. ED.] This result was only reached on Feb. 22, 1888, when the Mindi Cut, was completed by the great dredge. The course of the canal from coast to coast is just 74 kilometres, or about 45¾ miles, in length. The section opened by the completion of the Mindi Cut, 4 miles out of Colon, is only a little more than the first contract division, which is 24 kilometres, or about 16 miles, long, extending from Colon to Bohio Soldado. There are five other contract divisions of the work, on which operations are now being pushed. French enterprise and skill and French money, of which there seems to be plenty available just now, may be able to finish the other five sections by the lock system within 5 years. Mr. SLAVEN says this will be done. If FERDINAND DE LESSEPS, who is now 83 years old—not a great age for great men on the Continent—should live in health to be 88, there is little doubt that he will succeed, by the aid of M. EIFFEL, the builder of the famous Eiffel iron tower in Paris, in locking vessels across the isthmus. The action of the French Deputies a week or two ago seems to assure sufficiency of funds.

The American Dredging Company receives $500,000 a month for its contract work. It has now at work seven of the great machines shown in the illustrations. Five of them were built in New York, and cost, delivered at Colon, $160,000 apiece. The "City of Paris," the biggest and most ingenious of the Slaven dredges, is probably the largest dredge in the world, and digs through earth and rock or mud and water with equal facility. It excavates 12,000 cu. metres of earth a day, and is as nearly automatic as a machine can well be. The tower on the deck is 70 ft. high. The immense iron buckets each hold a cubic metre, and the material is conveyed to a distance of 150 ft. on either side. The operating staff consists of 20 boys and men.

An excellent idea of the vast operations necessary on every division of the canal except the first may be gained from the view of the high point at Pas Obispo, looking toward the Culebra, or mountain divide. *The dry bed of the canal* partially excavated is shown in the foreground.

The seven lines of railway show by their successive depression the herculean task it must *have been* to cut down a great hill into a spacious valley.

The most interesting, perhaps, of these views along the canal is that of the Culebra. [The right half of our view, from the same photograph, but more vaguely reproduced. ED.]. What was once a *solid continuous chain of rock is shown to have been cut away into a stupendous artificial gap*, up to which run the canal bed and parallel system of tramways found necessary to carry away the demolished hills.

The manager for the contractors for this division, M. BUNAU-VARILLA, was formerly a Director-General of the Panama Canal Co. The canal directors seem to have a great way of resigning and getting hold of fat contracts. He says he will have his work done by 1891.

Count DE LESSEPS is expected shortly on the isthmus. He was there in 1882, and again in 1885, just before his last visit to New York. He said then the canal would be finished in 1888 or 1889. Afterwards he put the date for its completion in 1890 at latest. Disappointed, perhaps, he has been in these predictions—more so than the world, which didn't much believe them—but he has done very much in the interval. He says now he has all the money he wants, and recalls the success of his Suez canal and the fact that it took 15 years to finish it.

The Actual Status of the Panama Canal.

PROVIDENCE, R. I., June 5, 1888.

EDITOR ENGINEERING NEWS:

I have been interested in reading the article published in the last issue of ENGINEERING NEWS (June 2) with excellent illustrations of the Panama canal. I enclose three cross sections (Fig. 1) which represent the beginning, the summit and the end of the

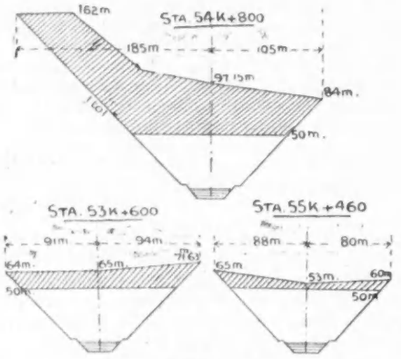


Fig. 1.
Official Cross-Sections of the Great Culebra Cut, at Center and at Each End.
[Bottom of summit level is now at + 40 m.]

Culebra Cut. The notes are from the working sections, taken from the company's office at Culebra in January 1885. I was at that time Chief Engineer for the Dutch contractors, who had just commenced, and had contracted to take out all material above elevation 50 m. from Kilo. 53+600 to Kilo. 55+460, or the areas hatched. Their contract price was $1.50 per cubic yard, a lump sum, to include rock or whatever the material might prove to be. The contract

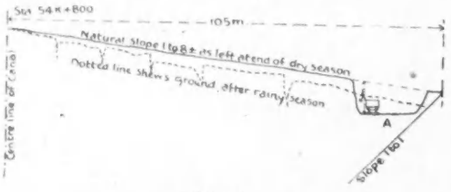

Sta 54K+800
105m
Natural slope 1 to 8± at its left at end of dry season
Dotted line shows ground after rainy season
A
Slope 1 to 1
Center line of Canal

Fig. 2.
Effect of a Rainy Season on Work at the Culebra Cut

was supposed to represent about $20,000,000. They were an energetic, intelligent set of men, and represented large capital in France and Holland; but after two years of hard work they retired from the field, as three or four other firms had done, declaring that they could not excavate the surface material and discharge it into the lateral valleys at that price, and they were not troubled with any rock to speak of.

The reasons why are numerous: First, you cannot work to advantage in the wet season, and as the rains increase, the material sticks to the buckets and shovels in such a manner that it is easier to work it by hand into balls and throw them into the dump cars. The heavy 80 lb. rails and hard wood sleepers work their way into the soft mud, so that it is almost impossible to move the track, and it would be better—at least put money into the contractor's pocket—could he abandon the work of excavating in the wet season.

After the rainy season is over, it takes a long time to get the tracks and dumps into working condition; and before one is aware the dry season is well advanced. Fig. 2, an instance from actual experience, will serve to show the effects of one rainy season on a natural slope of 1 in 8. A[1] represents a cut 5 metres deep, in good working order at the end of the dry season of 1884, with a train of dump cars and excavator left standing in the cut; the dotted line shows how the land slid during the rainy season for 100 metres back from the face of the cut, entirely burying the train of cars and most of the steam excavator. This seems to be the peculiarity of the greater part of the Culebra Cut. What then will be the effect when they have excavated to a depth of 100 or 200 ft. and expect to zig-zag their railways up the side slopes in order to reach the dumping grounds?

Another principal trouble to contend with is that of labor. The Jamaican negro, when I left the Isthmus, had pretty full control of himself, and decided as to whether he would work or not, and how much. To get a fair days' work out of him was impossible. To see 40 or 50 of them spend a whole day trying to shift a few hundred feet of track 10 ft., under the direction of a discouraged foreman who might be, anywhere else, an excellent man, was enough to frighten anyone against taking a contract unless they were paid a yard of cash for a yard of excavation. I believe that the Chinese are the only people that can be employed to advantage as laborers on the canal.

I should like to amplify the cross-sections, but I have no more notes, and the figures given on Fig. 1 do not check with themselves, comparing slope stake heights with distance out from center, although I know they were correctly copied from the originals. The summit section agrees with your longitudinal profile for center height.

On page 448 of your article, referring to the Culebra Cut, you say that about 93 ft. have been taken out, or say 30 metres, at Kilo. 54. Now by a glance at the very excellent sketch that you publish, and on which I have drawn contours, center line and side slope lines, (practically quite correct enough for argument) I see that is impossible.

[We reproduce our cut in Fig. 3, with Mr. SNOW's notes added.—ED. ENG. NEWS.]

I travelled over that section every day for six months and located the railroad running to the dumping grounds on contour 95 m. and it looks about the same in your view as it did three years ago. The work is, as you see by the contours which I have added to your view (Fig. 3) in 10 m. cuts, which is too high considering the treacherous material; 5 metres would be better and I see they have now an excavator at work on the 90 meter contour.

Now if at Kilo. 54 [at Atlantic end of great Culebra Cut, near left end of our view; see our profile published last week. ED.] they have excavated 30 m., everything should be finished above contour 65 m., while the photograph shows that no work is going on below contour 75 m., and that the present contractors have only got a fair start for all excavation above that level, and that is all that would be expected. The Dutch contractors did very little in 1885; they were considering whether it was best to go on or not in 1886, and the first of the present year the work went into new hands, which means three dry seasons lost, or practically so. When I left, the original center stake at Kilo. 54 had not been removed; certainly the present contractors have not dug 93 ft. below it, and taken care of those immense slopes, as the photograph clearly shows. The dotted lines on the cross-section given in Fig. 4 shows about what has been done at that point, by the testimony of the photograph.

Another great stumbling block to the early completion of the canal is the layer of hard sandstone found throughout the lower valley of the Chagres river at a depth averaging 6 metres below mean sea level, which means years of hard work on submarine blasting to excavate the remaining four metres. At the end of 1885 only one drill was at work once in a while, removing this obstacle.

Figs. 5 and 6 are intended to show how it is proposed to turn the Chagres river into the lateral canals where the main canal crosses it, which happens about 20 times. How the French engineers expect the dams to resist the pressure of the river, built as they are to be, in mud, I am unable to explain; but how the great floods will affect them, should they once be built, will be clear to engineers.

Fig 3.—The Great Culebra Cut.
[Reproduction of the view given in our issue of June 2, adding lines indicating the contours and center and side lines of the canal.]

The Chagres river, the Culebra cut, the great dam at Gamboa, and the underlying strata of hard sandstone in the lower Chagres river valley, together with hundreds of other obstacles of not much less magnitude, certainly make it reasonable to think that the next twenty years can go by, and the canal still remain far from finished. Eight years have already passed, and comparing the work done with what remains, it is safe to say, considering the multiplication of obstacles as the work progresses, that it is not yet fairly begun. The bottom hundred feet, at least, of the summit cuts would have to be dumped out to sea if the sea-level canal were ever constructed, which means a towage of 40 miles at either end.

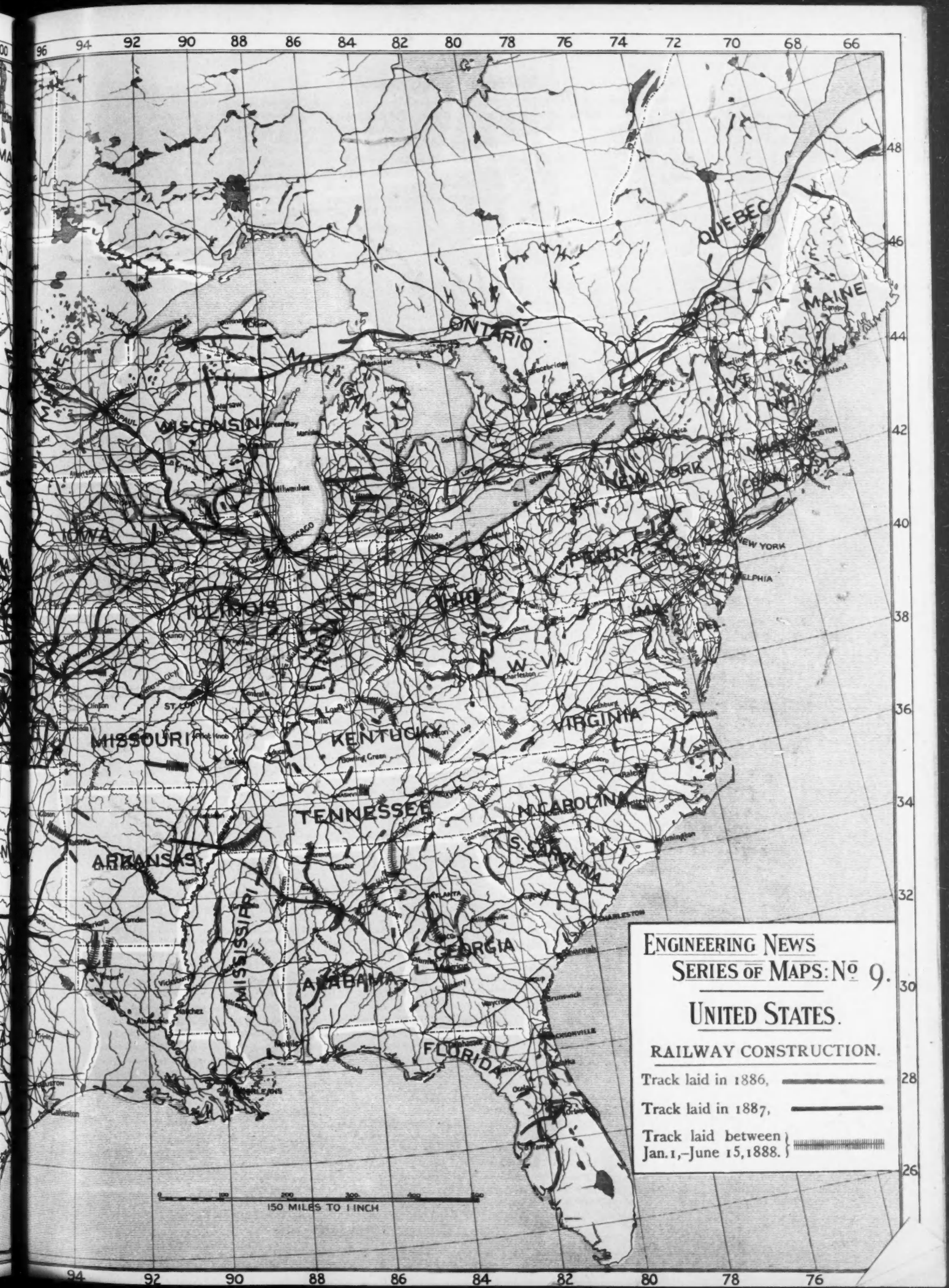
The same difficulties which menace a sea level canal also threaten the series of locks as proposed, as time will surely prove.

From July to October, 1885, I was Chief Engineer of the American Contracting & Dredging Co., at Colon. The monthly amount of work done by that enterprising firm of contractors is certainly wonderful, and if the canal should ever be finished it will be because their monstrous machines will have eaten their way through to the Pacific Coast. Unfortunately, that is impracticable, and in years to come when the whole work is abandoned, as it surely will be, the traveler to the Pacific Coast will only see the waterways cut by this company to remind him of the time when work was going on everywhere along the line. As for the rest, the

THIS MAP shows ALL the lines of railway within its limits in their correct geographical position as they stood on Jan. 1 of the current year. For railway lines in process of CONSTRUCTION, under SURVEY, or PROJECTED, see the large scale Maps showing the divisions: EAST OF CHICAGO, The SOUTH, The NORTHWEST, The SOUTHWEST, and ROCKY MOUNTAIN and PACIFIC, issued at frequent intervals as supplements to ENGINEERING NEWS.

CORRECTIONS AND ADDITIONS to this map and to all our published data of NEW CONSTRUCTION are especially requested. Every effort is put forth to make our maps ACCURATE and RELIABLE.

CHAS. HART & SONS LITH. 36 VESEY ST. N.Y.


ENGINEERING NEWS
SERIES OF MAPS: No 9.
UNITED STATES.
RAILWAY CONSTRUCTION.
Track laid in 1886,
Track laid in 1887,
Track laid between Jan. 1,–June 15, 1888.
150 MILES TO 1 INCH
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MICHIGAN
WISCONSIN
MINNESOTA
IOWA
ILLINOIS
OHIO
W. VA.
VIRGINIA
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MISSOURI
TENNESSEE
N. CAROLINA
S. CAROLINA
ARKANSAS
MISSISSIPPI
GEORGIA
ALABAMA
FLORIDA
NEW YORK
PENNA.
MASS.
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R.I.
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NEW YORK
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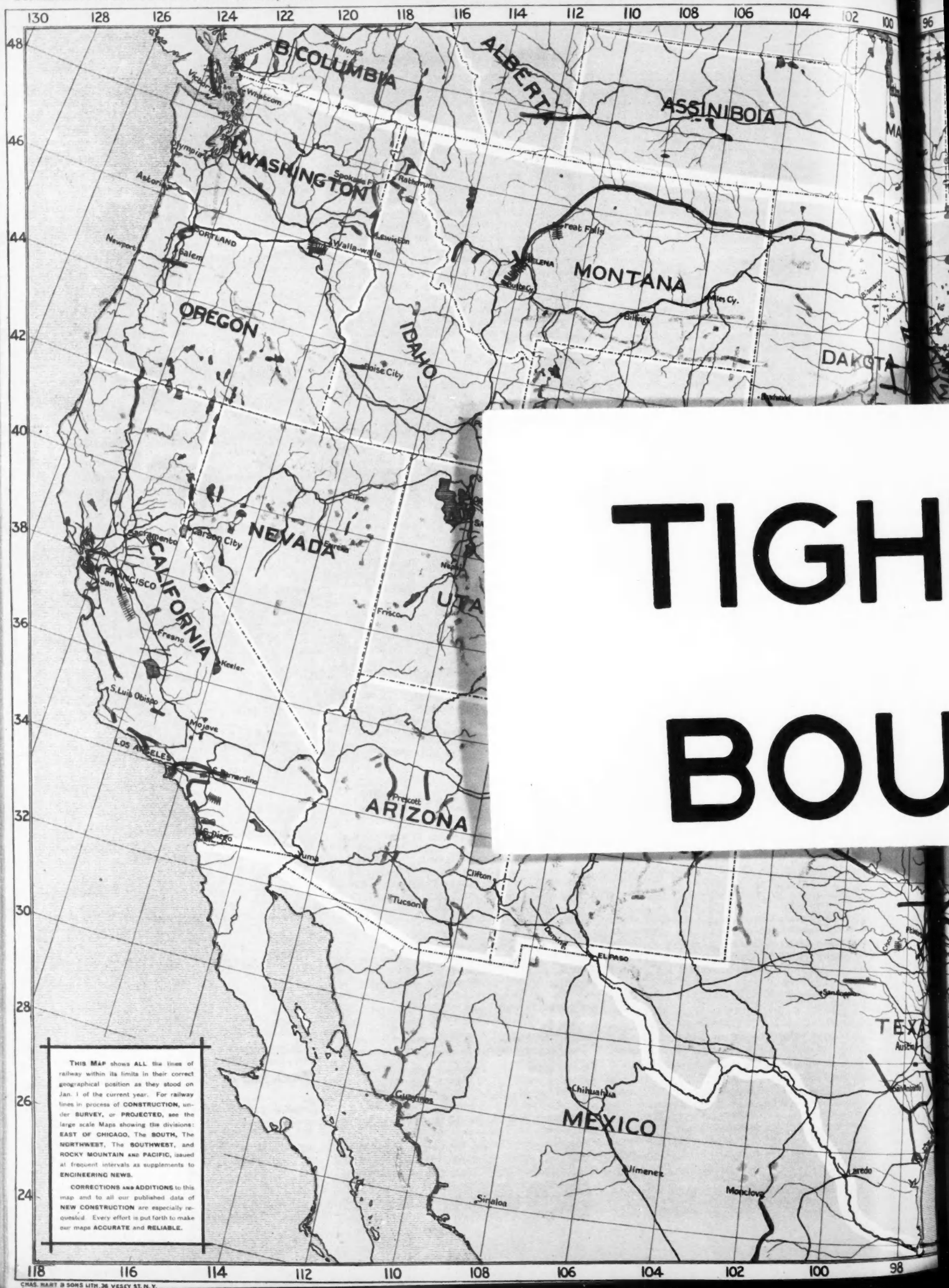

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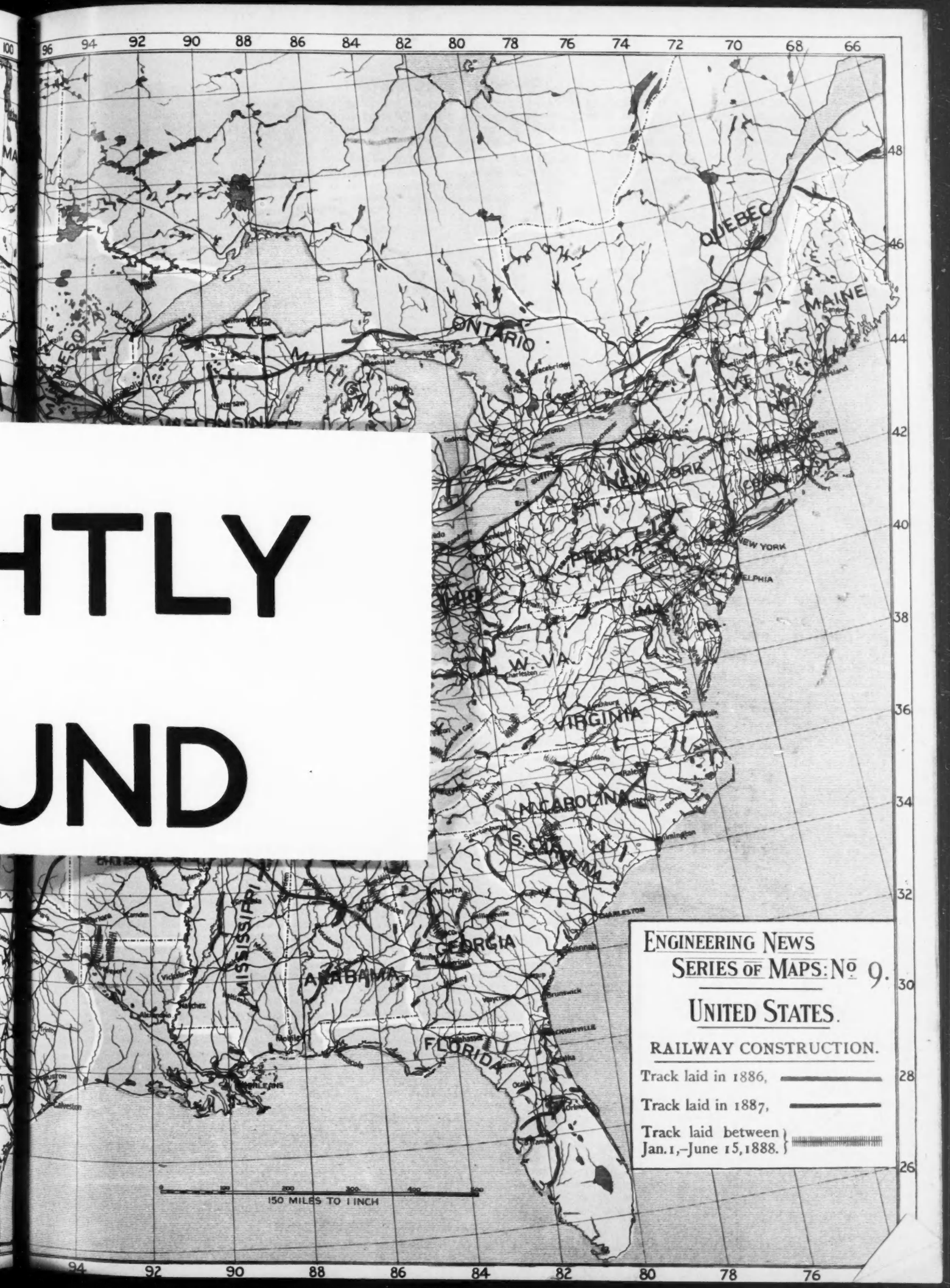
CHAS. HART & SONS LITH. 36 VESEY ST. N. Y.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heavy tropical vegetation will bury it out of sight and all traces of the canal will be lost.

The French system of doing the work is wrong. The fact that $300,000,000 [under $200,000,000 in cash. ED.] is already spent, does not prove anything to American engineers. *How many yards* have been excavated from the canal? That is the question. Beautifying the different sections with costly residences and country drives seems to convince the poor of France that all is well, but the longitudinal profile you have just published, which is undoubtedly correct, tells its own story.

It is now three seasons since I left the Isthmus but letters from friends, engineers in Central America, say: "The canal looks just the same, no perceptible change along the line and especially none at Culebra."

Very truly yours, F. A. SNOW.

[We have commented on this very interesting communication from Mr. SNOW on our editorial page. We will only add here that none of the information given in it, except the three cross-sections shown in Fig. 1, was volunteered by Mr. SNOW, and therefore cannot be supposed to have been dictated by any unfriendly feeling toward the canal, except as a regard for truth and the facts might necessitate such an attitude. He sent us immediately after our issue of June 2 appeared the cross-sections shown in Fig. 1 with a brief note to the effect that they would probably be interesting for comparison with our views and profile. We at once returned them with a request that he would amplify his communication, as he had enjoyed such opportunites for intimate knowledge of the condition and prospects of the canal, and especially point out any errors or defects in the matter we had published, or any injustice toward the canal management. The response was the above letter.

One fact which will at once attract the attention of engineers is the loose way in which the cross-sections shown in Fig. 1 are taken. For the two smaller cross-sections, 550 to 600 ft. across the top, there appears to have been only one intermediate level taken, the center-height, and for the larger section, nearly 1600 ft. across the top, only three intermediates. This in itself is a small matter, but it is certainly a straw of some significance. ED. ENG. NEWS.]

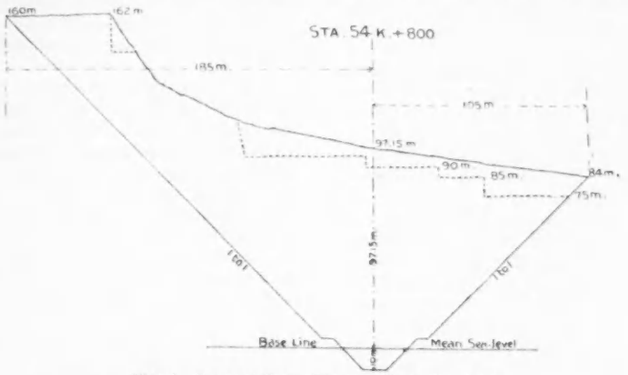


Fig. 4.—Largest Cross-Section of Culebra Cut.

[Showing by dotted lines the work already done as indicated by the photograph (Fig. 3). All the work is in sliding material, except the upper corner, which is in rock.]

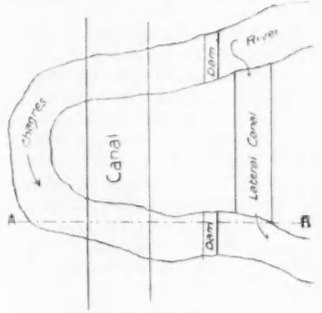


Fig. 5.

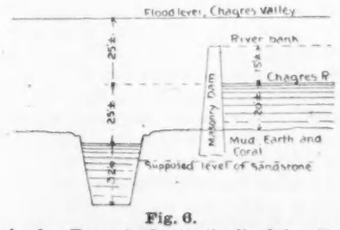


Fig. 6.
Sketch of a Typical "Derivation" of the Chagres River.

A Blue Process Formula.

HELENA, Ark., June 6, 1888.

EDITOR ENGINEERING NEWS:

Please inform me what are the chemical ingredients required to prepare the sensitizing fluid or fluids for making blue print copies of drawings.

Yours truly, T. M. J.

[The composition of a large number of sensitizing solutions has appeared at various times in these columns. One of the many, which is easy of preparation and works well, is the following:

1. { 1⅞ oz. citrate of iron and ammonia / 8 oz. water } Mix thoroughly.
2. { 1¼ oz. red prussiate of potash / 8 oz. water } Mix thoroughly.

Keep 1 and 2 separate until ready for use. For an ordinary blue ground mix equal portions; for a very dark blue use 2 parts of (1) and 1 part of (2).—ED. ENG. NEWS.]

Wanted.—A Treatise on Irrigation.

EDITOR ENGINEERING NEWS:

Can you inform me if there is any book published on the subject of "Irrigation"? I do not find any such work in your published catalogue.

If there is no book obtainable, you perhaps may know if there is any other literature on the subject such as reports or papers, published by any of the engineeering societies. I want to get something *practical* that may be of use in laying out a system of irrigation. Truly yours, TRANSIT.

[We do not know of any very practical book on the subject of irrigation, though there ought to be such a work. In the Transactions of the American Society of Civil Engineers, March, 1887, is a paper by Mr. E. B. DORSEY, with a number of discussions. There is also published in pamphlet form a very good paper on "Irrigation and Agricultural Engineering" by Mr. WALTER H. GRAVES, read before the Society of Engineers at a meeting in Denver, Col., June, 1886. There is also a book on "Irrigation in Spain," by J. P. ROBERTS, published in 1867. In the Ninth Annual Report, of the Ohio Society of Surveyors and Civil Engineers, Columbus, O., is a short article on "Irrigation in Kansas," by J. S. HUMPHREY, of Garden City, Kan. The "General Index to Engineering Periodicals," prepared by Mr. F. E. GALLOUPE, of 30 Kilby St., Boston, Mass., and about to be published, would probably be of use in this and similar cases; the subscription price is only $2. Perhaps some of our readers can add to the list of works on Irrigation.—ED. ENG. NEWS.]

A Hydraulic Conundrum.

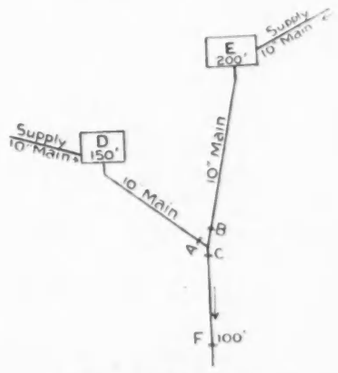
ASHEVILLE, N. C., June 5, 1888.

EDITOR ENGINEERING NEWS:

In the accompanying diagram *A*, *B* and *C* are gate valves in the mains, all of them 10 in., *D* and *E* are reservoirs at the respective levels of 150 and 200 ft. and *F* is a pressure gauge connected with the main leading from the reservoirs to the city, at an elevation of 100 ft. With valve *B* closed and *A* and *C* open the static pressure at *F* would be practically 65 lbs. per sq. in.; under the head from the lesser reservoir; with valve *A* closed and *B* and *C* open, it would be, say 87 lbs., under the head from the upper reservoir.

Suppose the main leading to the city closed by a gate at *F* and gates *A*, *B* and *C* all opened: All the mains shown would be filled and water would flow from reservoir *E* to *D*,—what would be the pressure shown by gauge at *F* under these conditions? Would it be more than 65 lbs. per sq. in.? And if so, how much?

The question occurs right here in actual practice. We have a reservoir and a stand-pipe situated on a hillside above our town and the bottom of the stand-pipe is elevated 60 ft. higher than bottom of the reservoir, and is about half a mile away from it. They are both connected by 10 in. mains with the main leading into the city for distribution.



A Hydraulic Conundrum.

The elevations I have marked 100, 150 and 200 ft., for even figures are really as below:

	F assumed as,	0
D (bottom)	130 (top)	150
E "	190 "	250

I do not see that the lengths of pipes enters into the question of static pressure, but they are approximately as follows:

From *F* (our Public Square) to Junction of mains 1800 ft.
From Junction to *D* 500 "
" " *E* 2500 "

We have no means of determining our pressure and I have had a dispute with another engineer on the subject. I claim that if gates *A*, *B* and *C* are all open, there will be greater pressure in the city (at *F*.) than would be indicated if *D* was connected with the distribution mains and *E* cut off. He claims we would only have the normal pressure of the lower reservoir. Yours truly, A. B. C.

[Our correspondent is undoubtedly correct in his position, and precisely what the pressure should be at *F*, within a small margin of error, may be determined without any very elaborate computations. If anyone chooses to make the computation we will endeavor to find space for it.—ED. ENG. NEWS.]

THE Wason Manufacturing Co., of Springfield, Mass, is building a palace car for the King of Portugal. The car will have a drawing room, buffet, private compartments, etc., and also sleeping berths. It will be handsomely finished and will cost about $20,000.

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D. McN. STAUFFER. A. M. WELLINGTON.

EDITORS.

GEO. H. FROST, - - - BUSINESS MANAGER.

Subscription. — UNITED STATES AND CANADA, $5.00 *per Year*; $2.50 *for Six Months*; $1.50 *for Three Months*; *Single Copies*, 12 *cents*. FOREIGN COUNTRIES, $6.56 *per Year, or* 3 *cents per number additional.*

Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

Drawings for publication *should preferably be in plain black and white, considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

Engineers' Club of Philadelphia Pa.—Regular meeting, June 16. Secy., Howard Murphy. 1122 Girard Ave.

American Railway Master Mechanics' Association.—Next meeting at the Thousand Islands, N. Y.; June 19. Secy. Angus Sinclair, Chicago.

Engineers' Society of Western Pennsylvania, Pittsburg, Pa.—Regular meeting, June 19. Secy., S. M. Wickersham, Penn Building.

Boston Society of Civil Engineers, Boston, Mass.—Regular meeting, June 20. "Stony Brook Dam, Cambridge Water-Works," by W. S. Barbour; "Quincy Dam," by L. A. Taylor. Secy., S. E. Tinkham, City Hall.

American Society of Civil Engineers, New York.—Regular meeting, June 20. Annual Convention at Milwaukee, Wis., commencing June 28. Secy., John Bogart, 127 E. 23d St.

Engineers' Club of Kansas City, Mo.—Regular meeting, July 2. Secy., Kenneth Allen, 19 Deardorff Building.

Civil Engineers' Society of St. Paul, Minn.—Regular monthly meeting, July 2. Secy., Geo. L. Wilson, City Hall.

Ohio Institute of Mining Engineers.—Summer meeting at Logan, O., July 11, 12, 13. Pres., W. H. Jennings, Columbus; Secy. H. S. Witzel, Kittanning.

New England Roadmasters' Association. — The 6th, annual meeting will be held at Boston, Mass., August 15, 16. Secy.; W. F. Ellis, Roadmaster, Providence & Worcester R. R., Woonsocket, R. I.

Roadmasters' Association of America.—Next meeting at Washington, D. C., Sept. 11. Secy., H. W. Reid, Waycross, Ga.

ONE of the subscribers to the modest little KUTTER fund who did not wish his name to appear, writes us:

"I am very much disappointed by the meagreness of the Kutter subscriptions. In asking you to withhold my name I was actuated less by modesty than by fear that my little contribution would look mean in company with those of the rich folks, or might be taken as a standard instead of somebody's $500. As it is, I don't think I care enough about it to go to the trouble of repeating the request. Verily its a cold world, my masters, and "C. O. D." must be the watchword of any one who is going to supply it with any commodity and does not want to be "*left*".

There is so much truth to the square inch in this statement that the pressure is too great for us, and we are compelled to let it escape to the printing office, along with the following meagre list of additional subscriptions.

Acknowledged last week	$78.00
E. Sherman Gould	5.00
J. Delfs	2.00
T. G. Baylor	5.00
J. P. Snow	1.50
A. M. Stager	2.50
Geo. H. Simpson	2.00
Total to date	$96.00

We have assurances that others of considerable amount are coming. The German—American Technical Society, among others, has taken the matter up. But we trust that individual subscribers will likewise help to build up the aggregate to the desired sum of $500. He gives twice who gives quickly, and twice or three times more who sends money to Switzerland.

THE various methods tested in London, New York, Berlin and other cities, for the rapid removal of snow from the highways, have so far resulted in failure, partly from being found too costly and partly from being impracticable. The Paris Municipality, too, has caused numerous unsuccessful trials to be made, until now it appears that it has finally decided to adopt the plan of melting down the snow by means of salt, for the present at least. This method can be applied as soon as the depth of the snow layer amounts to one inch, and from that up to five inches. In various districts of the city salt-depots have been established where the street cleaning gangs, led by their foreman, fill their wheelbarrows. The salt is thrown out upon the snow either by hand, or with a shovel. The traffic of horses and vehicles of all sorts helps to soon mix the salt with the snow, and before two or three hours have elapsed, a liquid mass of slush has been formed which can easily be removed with brooms and scrapers. Together with the salt some sand is also thrown out.

While this plan is carried out to its full extent on the roadways, a scant amount of salt only is thrown upon the footwalks, the mixture of snow and salt being too cold for human comfort and health. In Berlin, where this method was used largely some years ago by many house owners to clear their pavements of snow, the police had to step in and forbid the use of salt, partly for sanitary reasons, and partly, as was claimed, on account of the destructive effect of the salt slush upon the footgear of the Berlinese. But passenger railway companies in Berlin, as well as in most cities of the United States, strew salt freely on their tracks regardless of the effect it may have upon their horses.

The salt used in Paris is obtained from mines in the East of France. It is used in its impure state, its cost being a trifle over $6.00 a ton. For one square yard about ¼ lb. of salt is required. In 1885 the total outlay for the removal of snow for the city of Paris amounted to $70,000, against $210,000 in 1882, the difference being due either to a more economic administration of the department, or to lighter falls of snow in 1885.

THE favorable report of a Congressional Committee on an aerial navigation scheme, with a recommendation to appropriate $150,000 for it on certain conditions, as recorded elsewhere, will be more likely to cause mirth than anything else, and probably justly so, since the odds are immensely against any one specific plan of the kind; but it must not be forgotten that the conditions have been greatly changed in recent years by the progress of the arts in one respect at least, the possibility of transmitting indefinite power through a little wire, and hence that the successful carrying out of some such plan no longer ranks *a priori* among the evidently impossible things.

We have no knowledge of the details of this particular scheme, but there would certainly seem to be a field worth study in the possibility of maintaining a constant connection with the ground and using the "balloon" feature merely to eliminate weight, so that the "ships" could be driven through air as a ship is through water, parallel with the earth's surface. That great speed would be theoretically possible under such conditions is beyond dispute, and with adequate power to maintain good "steerage-way" the maintenance of the electrical connection is likewise not beyond conceivable solution. It is hard to say what problem the genius of the nineteenth century may not yet tackle, and it has struggled successfully with more unpromising ones than this.

IT is a well known fact that the surface of paving blocks of the usual prismatic shape, be the material ever so hard, will gradually assume under wear an appearance more or less truly spherical, showing a more rapid destruction of the material along the edges, and at the corners than over the rest of the upper face of the stone. As stone pavements, however, are very expensive, it must be conceded that a pavement of blocks of equal hardness, which will wear uniformly over their entire face, so that their original plane is preserved, will represent a great economic advantage over the customary article.

The *Deutsche Bauzeitung* is authority for the statement that the artificial paving-blocks manufactured at Budapest, Hungary, out of coal-dust, loam, etc., and brought upon the market under the name of *keramite pavement* fulfill the said requirement. As the hardness of these blocks is stated to be also very considerable, it may be assumed that a pavement laid with such brick will stand the wear very well.

The cause for the natural paving stone losing its plane shape so soon must be sought, perhaps, to some extent, in the fact that by the concussions the material receives in being worked with mallet and chisel, the cohesion of the molecules so treated and of those in their vicinity, is lessened to a considerable degree. Hence edges and corners of chiseled paving stones are already frail and brittle when the block leaves the hands of the cutter.

With the artificial paving brick, on the other hand, corners and edges are the strongest portions, for the reason that the brick is just pressed into a mould from which it issues into sharp edges. It is then again subjected to compression in a mould having chamfered edges, an operation resulting in a brick with edges and corners more tightly compressed than the rest of the block, and therefore better suited to stand the wear of attacking wheel tires and horse's hoofs.

WE are glad to learn that public sentiment in Philadelphia, as represented by the daily press, is now practically a unit in favor of the early fulfillment of the plans which have been matured by the Reading Railroad managers for the improvement of the terminals in that city. The City Councils, however, after two months of dawdling, seem no nearer to taking action on the ordinance granting right of way to the company, than they were at the beginning. The present aggravating method of delaying action is by dilating on the advantages of an underground railroad for the Reading entrance to the city instead of the proposed elevated structure. This is an old game in Philadelphia. Every recent scheme for elevated rapid transit lines in the city has been defeated by large talk in reference to the great superiority of an underground line. President SMITH, of the Common Councils proposes to show by the testimony of "competent engineers" that the objections to the underground system with reference to bad ventilation, etc., are groundless. He is also reported as saying, "The officials of the railroad company expected Councils to arrive at a conclusion in sixty days on a subject that has required sixty years of consideration by men

who have made railroad and transportation work the business of their lines." The logical sequence is that Mr. SMITH expects that it will take the members of Councils, who are not versed in railway affairs, considerably over sixty years to make up their minds on this matter. The truth is that any corporation or individual who is dependent on the favor of a Municipal government is deserving of the commiseration of every right minded man.

WE find in *Engineering* the following valuable information as to car wheels:

"It is stated that the Pennsylvania Railroad Co. is obliged to replace annually 1 out of every 250 of its chilled cast iron wheels, or 4 per cent. On the Lake Erie line the figure is still higher, as 6 per cent. have there to be replaced every year. The steel-tired wheels on the Pennsylvania give much better results, as only .01 per cent. have to be removed yearly."

Where this information came from we cannot say. It is apparently thought to be condemnatory of chilled wheels, but as each wheel averages, at the least calculation, 15,000 miles per year, and as the percentage stated amounts to a 25 year life on the Pennsylvania and 16⅔ years on the other line, the Pennsylvania is probably bearing up with some equinimity under the burden of renewing cast wheels after only 250,000 to 375,000 miles of life, and does not sigh overmuch for the "steel tired wheels" which certainly do "give much better results" if the .01 per cent. of yearly renewals, or life of 10,000 years, be in fact what they are obtaining. It is strange how such palpable absurdities ever get into type, for there probably never yet has been a year when the Pennsylvania has not renewed far more than 4 per cent. of its cast wheels, or when it put forth any statement to warrant an assertion that "only .01 per cent. of steel tired wheels have to be renewed yearly", although there may possibly have been years in which they did not actually renew any more than that, since they have very few in their service

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WE regret to learn of a most distressing accident in the family of Mr. THOS. C. KEEFER, President of the American Society of Civil Engineers, by which the lives of two of his grandsons and a daughter were lost. The two boys were swimming in the Ottawa river when the swell of a passing steamer overwhelmed them. The daughter rushed to their rescue and all three were drowned. Mr. KEEFER will have the sympathy of the entire engineering profession in this great affliction.

Railway Construction in 1886 and 1887.

With this issue we publish Map No. 9 of our series, showing the progress of railway construction from Jan. 1, 1886, up to the present time. This series of maps, with the accompanying lists of work and editorial comments, we may say, without prejudice, gives a better presentation of the progress and prospects of American railway construction than anything ever before published. Realizing the value of accuracy and completeness in work of this sort, and the danger of misleading by the publication of incorrect figures, we have devoted an amount of time and expense to the work of collection and compilation of our railway records which, to the best of our knowledge and belief, is not equalled by any other bureau of railway statistics in the country. The list of the new lines of 1887, published elsewhere, is compiled almost entirely from official returns from the Chief Engineers of the companies, to whose courtesy in filling out our blanks we acknowledge our great indebtedness.

Through the courtesy of the publishers of Poor's "Manual of Railroads", whose reputation for accuracy is everywhere conceded, we have also been able to check our list for 1886 and 1887 by their official returns. We feel safe therefore in commending the list of the work for 1887 as thoroughly reliable. At the same time "it is human to err", as every engineer, at least, has painfully learned; and we repeat our request that our readers and correspondents who see in our published records anything which they know to be an error will kindly drop us a postal card and set us right.

But to the ordinary mind the statements that 8,471 miles was added to the railway mileage of the United States in the year 1886, and 12,668 miles in 1887, have but little significance. Figures and statistics may contain a vast deal of information, but only a trained mind grasps their full import. It is otherwise, however, with graphical representations, and the map and diagrams which we present herewith make easy of comprehension the important facts in relation to the railway construction of the past two years. The new lines of 1886 were mapped and described in our issue of July 9, 1887, but we reproduce them on the present map in order that the work of the two consecutive years may be readily compared.

The most prominent feature of the map is the network of lines which were laid down during the two years in Kansas and Nebraska, and it seems a natural conclusion that railway building in these States has been overdone. It is certain that the companies who have built these lines have discounted the future pretty heavily, and are relying on great future density of population and bulk of traffic; but the natural resources of the States seem to warrant this.

It is also true, however, that the real estate speculation which has run riot in this section for the past two years has had a certain influence on railway managers. They have been conservative when compared with the speculators whose so called enterprise has been more commented upon than its importance deserves. But they have in some cases been tempted by heavy subsidies and prospective gain to build lines to reach embryo cities and to parallel competitors whose evil fruits must some day be manifest. A writer in the June number of *Harper's Magazine* speaks enthusiastically of the progress of "urbiculture" in Kansas. It must be the opinion of every intelligent observer that the State has had altogether too much of "urbiculture" for her own good, and in so far as the railways have aided this city plotting fever they have done work of which much will ultimately result to their hurt.

But to only a few of the lines does the above criticism apply. Most of the railways in this broad belt west of the Mississippi have their excuse for being and their future mission in the rich fields of grain through which they run; the development of the agricultural resources of a region formerly supposed to be a desert has been a most salient feature of the past year's railway work. It is but a few years since the 100th meridian was considered the western limit of profitable agriculture, while the country for 100 miles east was a debatable ground where drought and grasshopper visitations alternated with occasional years of good crops. But our map shows a whole network of railway lines between the meridians of 98° and 100°, while 11 lines have been built across the 100th meridian in Nebraska, Kansas and Indian Territory within the past two years and four have crossed the 102d meridian. It is remarkable to notice as we follow down the map from top to bottom in the vicinity of these meridians how all these new lines are stretching out nearly due west. There is hardly a north and south line to be found west of the 99th meridian until we reach the Rocky mountain region; but of lines which have been pushed westward within the past two years and whose present terminus is evidently but a temporary one, there are in Dakota six, in Nebraska four, and in Kansas ten. The work in Kansas is due almost wholly to the Atchison, Topeka & Santa Fe, the Missouri Pacific and the Chicago, Rock Island & Pacific's subsidiary system, the Chicago, Kansas & Nebraska.

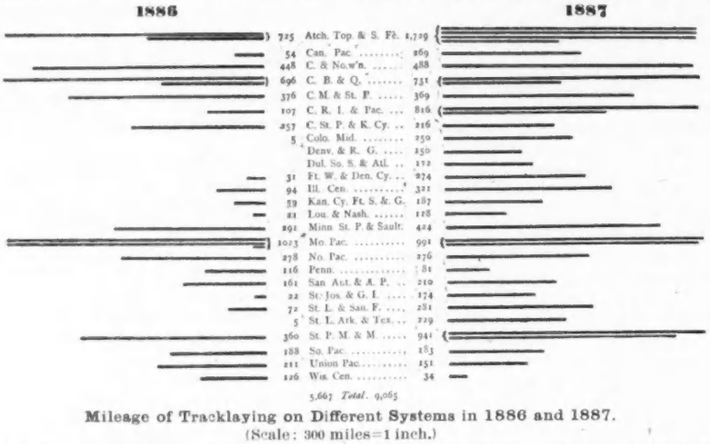
The year 1887 was remarkable for the number of very long and rapidly built extensions, which made up the great part of the season's work. At the head of these in length and rapidity of construction was the extension to Helena, Montana, of the St. Paul, Minneapolis & Manitoba system. This line has been often discussed as if its sole purpose was to be a competitor to the Northern Pacific, but our map makes it clear that the two lines are so far apart as to be absolutely non-competitive except on through traffic. The rich Milk River valley which has just been opened to settlement, will doubtless be rapidly brought under the plough and amply justify the wisdom of the builders of this extension. The two most important of the long extensions farther south are the lines of the Chicago, Burlington & Quincy system to Cheyenne, Wyo., and the Missouri Pacific's Pueblo line. Neither of these, however, has had such an effect in unsettling railway rates all over the country as has the new Panhandle Route or Denver, Texas & Ft. Worth, which was finished last March. Over this line the Denver merchants have been able to secure freight rates from New York to Denver *via* Galveston much less than those formerly charged *via* the all rail routes. Aside from its importance in regard to through traffic, this line opened up a section of the country which was more distant from railway facilities than any section of equal fertility in the United States. Now, however, it has been given an outlet in three directions. The Kiowa extension of the Santa Fé is completed to its center, and other lines are aiming in this direction. The new lines of the Santa Fé and of the St. Louis & San Francisco across the Indian Territory, show prominently on the map, and are of especial interest now that JAY GOULD is claiming that it was the division of traffic which resulted from their construction, which sent the Missouri, Kansas & Texas Company into bankruptcy. In Texas the principal work has been about the two railroad centers in the northern part, and the San Antonio & Aransas Pass extensions in the south.

Those who have watched the development of the "New South" will perhaps be surprised to see how small a showing is made by the work of the past two years in that section compared with that made by the West and Northwest. It is noticeable, however, that the present year is already showing a large amount of work in the South, and it is to be remembered that a mile of railway in this section represents in general a much greater outlay than on the western prairies. Birmingham, Atlanta, and the Florida lake region have been the principal centers of active work. The activity there this year is very notable.

The extensions in the States east of Chicago call for little comment. They are all short lines, and whatever their local importance, they make little show on the map in comparison with the work in the West. Michigan built 783 miles in 1887, but most of its new lines are mainly for the development of timber lands. Much of the work in Pennsylvania, Ohio and Indiana was in the coal mining districts.

The work in Canada includes two very important lines, the Montreal & Smith's Falls and the Sault Ste. Marie extensions of the Canadian Pacific system. The Province of Quebec shows a considerable mileage for 1887, and some work has been done in the eastern Provinces beyond the limits of our map, but included in the list published elsewhere.

Passing to the opposite end of the map, we note as the most important of the new lines on the Pacific Coast, the California & Oregon extension of the Southern Pacific system, which though short, was one of the most difficult pieces of railway construction of the year. Southern California has been an active region for the past year, and the work there is still in progress. It is but a small bit, however, compared with the work in other sections. The country about Los Angeles is doubtless destined to permanent prosperity as a health and pleasure resort; but that its commercial importance can ever compare with centers which handle the agricultural products of the Mississippi valley is not for a moment to be believed.

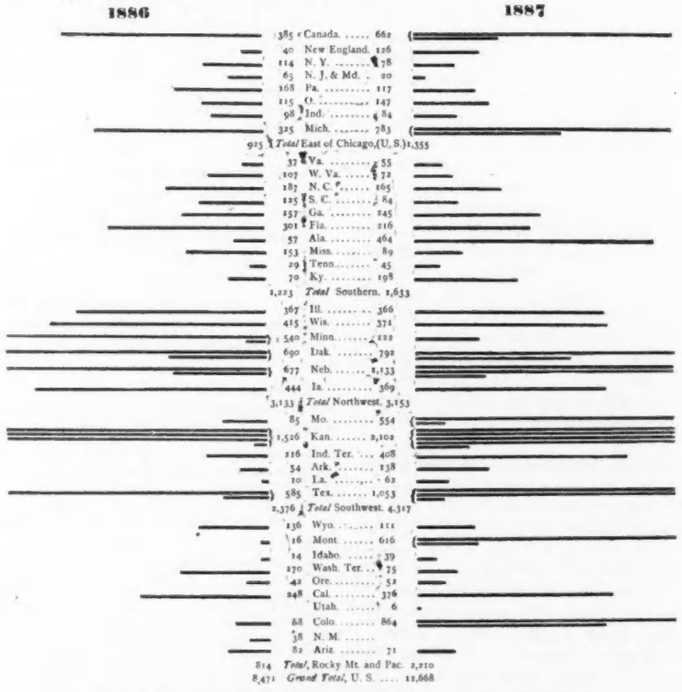

1886
1887
725 Atch. Top. & S. Fe. 1,729
54 Can. Pac. 269
448 C. & No.w'n. 488
696 C. B. & Q. 731
376 C. M. & St. P. 369
107 C. R. I. & Pac. 816
257 C. St. P. & K. Cy. 216
5 Colo. Mid. 250
Denv. & R. G. 250
Dul. So. S. & Atl. 122
31 Ft. W. & Den. Cy. 274
94 Ill. Cen. 321
59 Kan. Cy. Ft. S. & G. 187
81 Lou. & Nash. 128
291 Minn. St. P. & Sault. 424
1023 Mo. Pac. 991
278 No. Pac. 276
116 Penn. 81
161 San. Ant. & A. P. 219
22 St. Jos. & G. I. 174
72 St. L. & San. F. 281
5 St. L. Ark. & Tex. 229
360 St. P. M. & M. 941
188 So. Pac. 183
211 Union Pac. 151
126 Wis. Cen. 34
5,667 Total. 9,065

Mileage of Tracklaying on Different Systems in 1886 and 1887.
(Scale: 300 miles=1 inch.)

The whole vast area of Idaho, Nevada, Utah Arizona and New Mexico contains only a few unimportant lines as its record for the two years. The State of Colorado, however, shows a remarkable amount of work; comprising, too, some very heavy and expensive construction, on the Colorado Midland and Denver & Rio Grande lines. The extensions of the Missouri Pacific to Pueblo and of the Burlington system to Cheyenne were much less expensive pieces of work, though hardly less important, as they give two new competitive routes to the East.

But the matter of greatest interest in connection with the railway construction of the past two years is yet to be considered. It is the matter of the new competitive routes between the East and West. Great as has been the agricultural development of the Mississippi valley, and with all the cities that have grown wealthy in its midst, the chief market for its products is still found on the Atlantic seaboard. The three commercial centers of New York, Philadelphia and Boston alone contain at the present time a population of about 5,000,000, and Baltimore and the minor cities of New England, New York and Pennsylvania bring up their total urban population to considerably more than a tenth of the total population of the country. Remembering that this population is dependent upon the West for its main supplies and that it is at the ports of these seaboard cities that our surplus agricultural products are shipped to foreign countries and the imports from them are received, and it is readily seen why the great bulk of the country's commerce flows in a stream between the chief markets of the West and the cities of the East.

The city of Chicago has long held undisputed pre-eminence as *the* trade center of the whole West, and the great railroad systems centering there have assisted in maintaining the precedent that all traffic between the East and West must pass through Chicago. But within a score of years a rival metropolis has grown up about the falls of St. Anthony on the Mississippi. The "Twin Cities", Minneapolis and St. Paul, have long been restive over the fact that their flour and grain had to pay tribute to Chicago in its journey to the Eastern markets. It mattered not that the competition for the traffic between the two cities has resulted in the building between them of three additional railways in the past two years.



Mileage of Tracklaying in the Several States in 1886 and 1887.
(Scale: 300 miles=1 inch.)

The Minneapolis flour princes determined to have an outlet to the East independent of the Chicago roads, and during the past two years they have pushed a railway through the forests of northern Wisconsin and Michigan to the Sault Ste. Marie where it was met by an extension of the Canadian Pacific. By this route the products of the wheat fields of Minnesota and Dakota can reach the seaboard, either by an all rail route, or by a transhipment at a new port at the northern end of Lake Michigan, by a water route much shorter than the roundabout detour necessary when shipped *via* Chicago. The financial backing of the new company is furnished by the Canadian Pacific and the wealthy millers of Minneapolis, and its continued independence is well assured.

Nor are the cities of St. Paul and Minneapolis Chicago's only rivals. The city of Duluth is soon to be the eastern terminus of two great systems, the St. Paul, Minneapolis & Manitoba and the Northern Pacific. It is many hundred miles closer to the wheat collecting centers than Chicago and the distance to the seaboard through the lakes is no more. It has also a line of railway to Sault Ste. Marie and bids fair to some day rival the Twin Cities as a grain market.

The cities of the Northwest have succeeded in making themselves independent of Chicago, but the products of the sections further south still find their chief market there. Kansas City and Omaha, especially the former, would gladly be independent of their strong rival on the lake, but their attempts to find an outlet directly to the East or to Southern ports have thus far been unsuccessful. The rapid growth in importance of Kansas City, however, has resulted in the building of three lines of railway during the past year to compete for the traffic between Kansas City and Chicago, an extension of the Chicago, Milwaukee and St. Paul system, the Chicago, Santa Fé & California line and the Chicago, St. Paul & Kansas City extension, now completed to St. Joseph, Mo. There can be little doubt that within a few years the cities of the Southwest will succeed in some of their efforts to obtain a favorable route to the seaboard independent of the present one *via* Chicago; but even then it will be a slow process to change the course of trade, and the city of Chicago is doubtless destined to remain permanently in advance of all her rivals.

The diagrams which we present of the work done in the different States and on the different systems tell their own story. In the record for 1887, Kansas is at the head of the list with a new mileage of 2,102 miles and then follow Nebraska, Texas, Colorado, Dakota, Michigan, Montana and Missouri in the order named. In each of these over 500 miles of railway were built, and the total for the

eight States is 7,897 miles or about $\frac{3}{13}$ of the whole mileage of the country. The growth of the different systems as shown by the diagram, is of still more importance than the summary by States. The 26 systems given in the list, contain nearly three-fourths of the new mileage of 1887. The 1,729 miles built by the Atchison, Topeka & Santa Fé, it is safe to say, is the greatest mileage ever added to a railway system in a single year. The four other systems which built more than 500 miles in 1887 were the Missouri Pacific, 991 miles; the St. Paul, Minneapolis and Manitoba, 941 miles; the Chicago, Rock Island & Pacific, 816 miles and the Chicago, Burlington & Quincy, 731 miles; a total on the five systems of 5,208 miles.

We had intended to present in this issue a list of the work for the current year which we have shown upon the map, with some remarks on the present and prospective status of the work of railway extension; but the pressure on our space compels a postponement to a succeeding issue.

More Light on the Panama Canal Question.

We had expected that the information given in our issue of June 2, including as it did the first definite progress profile ever published, would exhaust all there was to know or to say on this question, for some time at least. But it is the nature of any such information to call out more, if it exists; and some of no little importance appears in this issue, besides which, a good deal is being done and being published in France just now, with which it is difficult to keep up without giving a good deal of space to it.

Whether this information originates with those friendly or unfriendly to the canal, it appears to us certainly calculated to deepen the painful impression of the earlier recorded facts. Thus, to begin with DE LESSEPS himself, what can be thought of the management of the canal when the head of it, after so many complete and mortifying failures of predictions, ventures in the most solemn and public way, before a large body of scientists to whom he had exhibited the same photographs that we have shown (although probably not the progress profile) to declare that the canal will "positively be opened in 1890," when there are only 8 dry months and 23 wet months intervening between now and the end of that year, and 7 years' work have only accomplished what our profile and illustrations show. It is self-evidently absurd, and if reason and sanity be not at the helm, what can be hoped from the largest expenditure in the future, more than from the large expenditures of the past? The most dangerous fault in contests with nature as in war is to underrate one's enemy, and the tendency to do this as respects the Panama Canal seems to grow stronger with time, rather than weaker.

This is conspicuous likewise in the letter which we publish from Col. NATHAN APPLETON, of Boston, LESSEPS' friend, lieutenant and ally in this country, which gives an interesting and true résumé of the excellent work of the American dredges but ignores the fact, so evident to engineers, that had the work been managed well and in good faith these powerful machines would not yet have begun their work at all, thus saving the interest and maintenance charges on the comparatively light and simple dredging work, which will double and triple their proper aggregate. And the letter ends with renewed and positive claims that the sea-level project is only in abeyance; that it is to be carried through after the canal is opened; when it has been clear from the first to every intelligent and unbiased engineer, and is still clearer now, that humanly speaking, such a result is impossible, short of a probable expenditure of over $1,000,000,000.

These same assertions as to the final construction of the sea-level canal are renewed also in the still more remarkable document which we translate from *Le Génie Civil*, relating to the water supply of the canal. When examined with any care this paper cannot but create or deepen unfavorable impressions. How does it happen that there are no records extending back of 1883 for so vital a question as the flow of the Chagres, when the project was definitely determined on in 1879 and the records should at least extend back to 1880? One cannot but feel that they must exist somewhere, and their lack makes it additionally suspicious that the records of the earlier years, when no flow at all was the desirable thing for the sea-level project, should show so small a flow—not enough to feed the lock canal for months together—while the records of 1886 show the greatest abundance. We would be the last to assert that these records may not be entirely correct, but we certainly can and should assert that the gradual and continuous change does not correspond with the usual course of meteorological events. No one who has had to do with taking such records can examine these without a feeling that they are probably inaccurate, if nothing else.

Passing that question, let us examine the engineering features of the proposed Chagres water supply. The Chagres is a terrible stream, which vibrates within a few hours between extremes of flow approximating to the limits of 10 and 1,600 cu. metres per second. Its bed at the site of the dam has from 10 to 40 ft. of sand and gravel on it before rock is reached, the sand being deepest ed of the stream. With a flood variously reported at from 954 to 1,336 c. m. per second, in 1885, it ran 1,600 ft. wide and some 15 ft. deep, discharging 36,500,000,000 galls. per day (138,240,000 cu. m.) evidently requiring a very considerable spill-way. What provision is made for it in the plans whose description we translate? None whatever, and it is difficult to see what provisions can be made with the earthen dam proposed.

In the plans of 1885, so far as there can be said to have been any, it was proposed to first dredge down to rock, and then build a dam of rock spoil, 400 m. wide at base, 4 to 1 outside slope, extending up to the level 167 ft. above sea, depositing clayey earth on the inside to seal the dam. A circular tunnel 20 ft. in diameter, starting between levels 83 and 103 ft., 1,640 ft. long and falling 30 ft., lined with iron, was to discharge one-fourth of the maximum flow, and the remainder, if continued for six days, would be held behind the dam, so that no spill-way was required. These plans were costly, but at least intelligible and consistent. It is now proposed to stop the dam at about level 90 to 100 ft. Dead low water is about 50 ft. above sea.

The reservoir which was to be filled in six days contained 1,215,000,000 cu. m. The reservoir at level 100 ft. will contain* about 160,000,000 cu. m. only. Hence the maximum discharge would fill the reservoir, if it were empty, in 26$\frac{2}{3}$ hours, but in the rainy season it would be chronically full. A spill-way tunnel adequate to take off the maximum discharge would have to be 40 ft. in diameter, and would have to be much longer than the higher and smaller one for the great dam, if feasible at all. Assuming it built, it amounts merely to leaving the Chagres wholly uncontrolled, the dam serving only to retain a supply available for pumping. If it is safe or possible to do this, and still operate the canal, why was a great dam at Gamboa ever proposed? No mention is made of these important difficulties, nor how they are to be overcome, in the plans which we translate.

So far, we have spoken only of new facts and statements put forth in defense of the canal by its avowed friends and partisans. When we come to the statements put forth by the enemies, let us say, or critics of the canal, they are certainly calculated to strengthen previous conclusions. The alleged absurd mistake in the financial calculations for the new loan which leave a little deficit of $48,538,634 in the proposed reimbursing fund may be passed by as only an unfortunate accident, but it certainly goes to confirm the indications of all the technical facts which have as yet appeared that the management is unintelligent; and what can be thought of such a showing as the great Culebra cut makes, when the photographic view is reinforced by the contour and slope lines which ex-Chief Engineer SNOW has added, in the very interesting communication which appears elsewhere? It is at once evident that hardly a beginning has been made on the great cut, while the easily executed and perfectly simple dredging work of the canal is almost completed. Again, the original sections reproduced in the cut marked Fig. 1, which appears elsewhere, are a straw of great significance to the engineer, as indicating the quality of the management. Only three levels per section were taken on the smaller cuts, and only five levels per section on this largest cut of the whole work, measuring nearly 1,000 ft. across the top. What reliance can be placed on quantities the original notes for which were taken in this loose way? And supposing the cut once executed, what probability is there of the slopes standing in view of such a showing as that of Fig. 2?

Again, if Figs. 5 and 6 correctly represent the character of the "derivation" works of the Chagres, as we believe they do, what probability is there of all of these works remaining intact through a single season, with such a dam at Gamboa as proposed? It is evident that these derivation works were planned with the idea that the Chagres was to be completely controlled by the large dam above outlined, permitting only one-fourth of its flow to escape at once. Those works, had they been built so as to stand, would have accomplished their end, and perhaps justified the derivation works. They have been abandoned as too costly, but the lower derivation works stand as before, and no change in their plan is suggested, although the flood level of the lower Chagres is 10 ft. higher than the top of the derivation dams.

It seems possible to explain such management only on one hypothesis: that it is proposed to go ahead trusting to luck; not attempting to plan the works so that they will really be permanent and adequate, but hoping that they may last a season or two, and that at any rate, the more money is spent on the canal the more urgent will be the pressure on past investors to put up enough to finish it, or consent to terms which will induce others to. But as the least sum which can be reasonably expected to complete the canal is $280,000,000 in addition to what has been spent, as we showed June 2, and as this estimate may rise to almost any sum before the whole work is finally complete, it seems to us extremely doubtful if the money to complete the work will be forthcoming and if so, it is a great pity to waste more money under the present management.

We regret to take so discouraging a view of so great and so much needed a work, but the facts seem to leave no escape from it, and the

* Special report of Lieut. W. W. Kimball, U.S.N., to Chief of Bureau of Navigation, 1886. p. 38.

financial and technical management of the work is, and has been, so shamefully reckless that it seems hopeless to look for much better things of the future than of the past. We have, until lately, been disposed to believe that the lock canal project would be carried through somehow, and have freely said so, but the more the actual status of affairs is looked into, and the more facts are collected, the worse the situation looks. If the management would but tell the truth, something might be hoped, however bad the truth was; but when we find them persistently asserting evident untruths, one cannot but feel that a collapse must come before long.

Does it then follow that the chances for an interoceanic canal are hopeless? Not necessarily. A very large fraction of the expenses incurred to date, and still to be incurred, may be regarded as due only to inferiorities of management. That is remediable on the same site. Another large fraction—a very large one—is chargeable to the climate, which is irremediable at Panama but is not an evil at Nicaragua or Tehuantepec. Still another, of as yet unknown but certainly serious magnitude, is chargeable to the eccentricities of the Chagres, which is also special to the site, and finally, there is no question but that the material has proved, on the whole, unfavorable, especially in the tendency to slide, and in the proportion of rock of a rather difficult character to work; which is another difficulty special to the site. In one slide on the Culebra section, within the field of our view, 78,000 cu. m. slid down into the cut. Other minor slides are visible in our view. The whole hill in the center of the picture seems to be unstable.

Another difficulty special to this location is the dubiousness of the water supply. This difficulty, also, is irremediable. We shall await with no little interest definite reports from Nicaragua; and the Eads ship railway project is also showing signs of life. Either of these projects is, we believe, practicable, and at a much smaller cost than that required to merely complete the "temporary" Panama lock canal. We refrain from discussing either of these outside projects in detail until more definite reports are available. Those from Nicaragua should be here soon. But in each project the doubtful elements of construction are comparatively trifling. Neither has climatic troubles of any moment, and the Nicaragua project has the immense advantage that although its whole length is nearly 170 miles, all but 36 miles is slack-water and lake navigation, involving no constructive difficulties, and nearly half of the remaining distance mere dredging work. Had DE LESSEPS taken hold of the Nicaragua route in the beginning, there can be little doubt that he would, by this time, have had the canal completed; but his determination to have a sea-level canal without locks, or nothing, will probably result in by far the greatest financial catastrophe of the century.

PERSONAL.

WELDON KEETING has been re-elected Superintendent of the water-works at Pueblo, Col.

G. McD. NATHAN has been appointed Contracting Agent for the Texas Pacific R. R., with headquarters in New York.

JOHN D. MOSS, C. E., has been appointed Street Commissioner at Athens, Ga., and has charge of the engineering and street improvement department.

H. W. BURFORD succeeds M. JOHANN as Superintendent of Motive Power of the Texas Pacific R.R. His headquarters are at Marshall, Tex.

EZRA K. BAKER, of Boston, Mass., a director of the Union Pacific R. R. Co., died at Boston June 7.

JOHN HUMBIRD, railroad contractor, died at Cumberland, Md., June 5. He built the Northwestern Virginia R. R., now the Parkersburg branch of the Baltimore & Ohio R. R., from Grafton to Parkersburg, W. Va.

J. A. FICKINGER has been elected Chief Engineer of the Ohio River R. R. Co. GEO. W. THOMPSON is President and J. M. CAMDEN, Jr., Secretary of the company. The offices are at Parkersburg, W. Va.

J. A. L. WADDELL and W. D. JENKINS, Civil Engineers, have formed a copartnership, at 118 W. 6th St., Kansas City, Mo., for the purpose of making and submitting designs, estimates and reports upon large and important bridges and such works as may require especial professional skill and superintendence.

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—The detailed announcements for the annual Convention, at Milwaukee, Wis., are as follows: The sessions will begin on Thursday, June 28, and continue on Friday, Saturday and Monday. Visits to places of interest will be arranged by the local committee, including one to Appleton and neighboring points, where there is an extensive development of water power, very large pulp and paper mills, an electric street railway in operation, etc. It is expected also that arrangements will be made for a visit to Mackinac and Sault Ste. Marie, after the Convention, by those who desire to make such a trip.

The Womans' Club, of Milwaukee, will tender a special reception to the ladies accompanying the Society.

The railroads at Milwaukee will honor the certificates issued at any point by the ticket agents to the effect that full fare has been paid to Milwaukee, and on presentation of such certificates, duly endorsed, after attendance at the Convention, will sell a return ticket at one-third full fare. No tickets should be purchased before June 25.

The Hotel headquarters at Milwaukee, will be at the Plankinton. A special train will leave the Grand Central Depot, New York City, on Tuesday morning, June 26, at 10.25 *sharp*, as a second section of the Limited Express, over the New York Central & Hudson River, the Michigan Central, and the Chicago, Milwaukee & St. Paul railroads. It will stop at Poughkeepsie, Albany, Utica, Syracuse, Buffalo, Niagara Falls, St. Thomas, Detroit, Ann Arbor, Jackson, Marshall, Kalamazoo. Arrive Chicago 12.30 Wednesday noon. Leave 2.00, and arrive Milwaukee 4.30, Wednesday.

In addition to papers and discussions already announced, the following will be presented and discussed: "Maintenance of Steel and Timber Track on Netherlands State Railways for 1887", J. M. POST. "The Cable Railway on the New York and Brooklyn Bridge", G. LEVERICH. "High Masonry Dams", JAMES D. SCHUYLER. "Syphons used by the Kansas City Water-Works", G. W. PEARSONS.

Engineers' Club of Philadelphia.—The regular meeting was held June 2; President JOSEPH M. WILSON in the chair; 27 members and 1 visitor present.

Mr. A. MARICHAL read a paper on the "Public Health of Cities and Towns", of which the following is an abstract:

Water Supply. In many cities the water-works are supplied neither with filters nor subsiding reservoir, and, after a heavy rain, the water contains clay powder which is decidedly injurious, especially to children, causing inflammation of the bowels and other troubles, the cause of which is generally unknown, although thousands of people are affected. If every property owner would consider a filter a no less essential part of a dwelling than a bath tub or a water closet, a supply of pure water would be enjoyed by the poor as well as by the rich, and without appreciable cost to anyone.—*Drainage.* The system of sewers should be such as not to allow any filthy matter to remain in it more than 12 hours. To obtain these results the sewers should have sufficient slopes and should be flushed every day. The flushing can be attended to by the police, consequently without extra cost for labor, and that by simply opening the fire plugs, thus cleansing the gutters and the inlets and accelerating the flow in the sewers. Manholes should be made air tight. Ventilation pipes should be placed at the *upper part* of the sewer, should be extended under the pavement to the house line and thence carried above the roof of the buildings. These pipes need not be of large diameter, but should be numerous. Cesspools should be strictly prohibited. It is well known that the germs of cholera are transmitted through the fecal matters. In a city where cesspools are allowed, it would be impossible to control the ravages of the disease.—*Paving.* The very first thing to be thought of in paving a street is to provide gutters with sufficient slopes. Belgian blocks placed lengthwise will make an effective gutter. The slope should be at least 0.5 per cent. Inlets should not be more than 400 ft. apart when streets are level. They should be made of cast-iron and not of bricks.—*Street Cleaning.* It should be done between midnight and 5 A.M., as it is unsafe to inhale all the dust accompanying this operation.—*Street Cars.* There are, perhaps, few causes contributing more to the increase of the death rate than the deliberate overcrowding of the street cars. Municipal authorities should limit the number of passengers to be admitted on a car.—*Dwellings.* The height of a building should never exceed the width of the street, and each story should be at least 9 ft. high. In any room where persons have to spend several hours, 1,000 cu. ft. of space per capita should be provided. Each room should have 20 sq. ft. of light per 1,000 cu. ft. of space, etc.

There was some discussion by Prof. J. W. REDWAY and Messrs. EDWARD HURST BROWN and HOWARD MURPHY. Prof. REDWAY approved the idea of opening the fire plugs daily, as it would also remove the silt collecting in the water pipes.

The Secretary presented, for Mr. W. S. SHEAFER, "Notes on the Coal Deposits of Sonora, Mexico". Part of the coal is easily accessible by rail and of commercial importance. The character of the coal is a good grade anthracite, showing, by analysis:

Fixed carbon	80.17
Moisture	8.45
Volatile matter	6.05
Ash	5.33

The Secretary presented, for Mr. A. W. SHEAFER, a note upon "Electric Haulage in Anthracite Mines." He refers to the progress so far made, etc., and gives the following comparison of cost with other methods:

COST PER TON-MILE.

Mules.	Steam.	Electricity.
$1\frac{32}{100}$ cents.	$\frac{8}{10}$ cent.	$\frac{3}{10}$ to $\frac{5}{10}$ cent.

The Secretary also presented, for Mr. A. W. SHEAFER, a photograph and description of the "Stripping of the Mammoth Coal Bed at the Shenandoah City Colliery Schuylkill Co., Pa".

The Secretary presented for Mr. G. W. JONES, a print and description of a valve motion which is claimed to be new, of the class in which the cut-off and the reversal of the engine are secured by the use of adjustable eccentrics. He also presented, for Mr. HOWARD CONSTABLE, a description of the Montague St. Electric Ry. and Elevated Terminal Station at Wall St. Ferry, Brooklyn, N. Y., illustrated by numerous drawings showing the difficulties of the situation, different forms of electric cars, etc. There was some discussion by Messrs. T. CARPENTER SMITH and HENRY G. MORRIS.

Prof. L. M. HAUPT presented an outline of a study entitled "The Great Transportation Areas of the United States", in which he determined the locus of the points from which the cost of transportation to tide water would be the same whether carried by rail entirely, or partially by river and rail, or by lake, canal and railroad. It resulted in a division of the country into five grand areas, of which the natural outlets were the Atlantic, Gulf and Pacific Coasts, the Mississippi River and the Great Lakes. The ocean rate being but about one-sixth that by rail, it was shown how important it was to reach tide-water by the line of least resistance. The Northern and Southern, or Lake and Gulf routes were briefly contrasted, and the importance of creating a deep water outlet for the grand railroad empire of the Southwest, was pointed out as being one of the most important of the transportation questions of the present and the future. The extent of territory tributary to the Gulf, as the nearest point for Eastern traffic, was estimated at about one million square miles. Attention was called to the Deep Water Convention, to be held at Fort Worth, Tex., July 10, and it was stated that the present available depth is but 12¾ ft., which is found on the bar at Galveston. Prof. HAUPT also presented drawings showing a method of building tunnels under rivers.

HOWARD MURPHY, *Secretary and Treasurer.*

Western Society of Engineers.—The 248th meeting was held June 6, the President in the chair. The minutes of the last meeting were read and approved.

Mr. LEWIS B. JACKSON, Chicago, Ill., was elected a member.

The President reported that the Trustees had not yet matured any recommendations as to the future policy of the Society, but that he expected to report upon the matter at the next meeting. He also stated that the Committee on Highway Bridges had taken action in carrying out the instructions of the last meeting. Considerable discussion occurred in regard to the functions of State Engineers in the several States and upon the general question delegated to the committee.

Upon motion of Mr. LILJENCRANTZ, a Committee upon Employment was ordered to consider and report at the next meeting, some plan and the necessary rules for carrying it into effect, for receiving and taking action upon applications for positions or for professional assistance from members of the Society. After some discussion Messrs. LILJENCRANTZ and PARKHURST were appointed as a committee.

The Secretary read a letter from Mr. W. S. POPE announcing the death of WILLIAM L. BAKER, of the Detroit Bridge and Iron Works, at his home in Detroit, on May 28. After remarks in regard to Mr. BAKER and also in regard to CHAS. LATIMER, Messrs. WESTON and LILJENCRANTZ were appointed a committee to report suitable resolutions upon the lives of Mr. LATIMER and Mr. BAKER.

The Secretary read a paper by ALVA M. VAN AUKEN upon "Classification of Material in Railroad Construction", and a supplementary paper upon the "Commissary in Railway Field Parties." The paper was discussed at length by Messrs. WESTON, GOTTLIEB, PARKHURST, LILJENCRANTZ and others. It was ordered that the paper be held until next meeting for further discussion, and that the remarks be put in writing for publication.

The next meeting was fixed for July 11.

L. E. COOLEY, *Secretary.*

New England Water-Works Association.—*Seventh Annual Convention.*—The Convention was called to order at 2.30 P. M., on the 13th, at the Firemen's Association Hall, Providence, R. I., by President DARLING, of Pawtucket, R. I. An address of welcome was delivered by Hon. GILBERT A. ROBBINS, Mayor of Providence, in which cordial invitations were extended to the members and visitors of the New England Water-Works Association to visit all parts of the city of Providence, the water-works system, city hall, and any and all points of interest.

In behalf of the Association, President DARLING thanked Mr. ROBBINS for his kind invitation, after which the President's address was read as follows:

Gentlemen of the N. E. Water-Works Association:

We are to be congratulated upon the number in attendance in this grand old city of Providence, a place of historical renown. It was to this place that ROGER WILLIAMS, fleeing from religious persecution in other lands, found his way, founding the city of Providence, and established the colony of Rhode Island. Here many of the largest industries of New England were planned and carried into effect; here GEORGE H. CORLISS, a man who had no peer, erected his plant and manufactured engines which were the admiration of the world; here, also, you will feel that good old Puritan hospitality extended with words of welcome and good cheer. And while we are here to-day let us remember that this city is bounded on the north by the city of Pawtucket, which also has its fund of historical reminiscences, and which joins in extending a warm welcome; for the two cities are so closely connected it is difficult to discern when you are out of one and into the other; and I might add that the two cities are mutually inclined to work harmoniously in their respective departments, especially in the fire department, where, on more than one occasion, in cases of most serious emergency, each city has rendered the other valuable assistance.

The fact of our meeting in this hall of antiquity must be to us all a pleasure and gratification. Its walls, hung with emblems of old times, carry some of us back to the days when we ran with the machine and the names of Button, Jeffers, and Hunniman, and others were familiar with all firemen. Later on came the fire engines known as the Amoskeag, Jeffers, and Cole with others. Now we see in many cities and towns, only the hose cart and ladder trucks which when the alarm of fire is given come rattling down the street and attach to the hydrant. That never gets tired, but keeps up a constant stream of water without the use of coal, or men on the brakes. This veteran Fire Association still retain the spirit of '76 and on proper occasions show that they have not forgotten what was instilled into their minds in former days And let me add here that the Water and Fire Departments of every town and city should always work in unison to produce results which both are personally interested in.

We are also to be congratulated upon the rapid growth of our association; beginning with a few members we now number 263, which number includes the best experts on all questions liable to be developed in our discussions. Our meetings during the past year have been of an unusually interesting nature, and important subjects have been made so plain that the "ordinary" mind could easily comprehend their results.

Our association is founded on the idea of the interchange of personal results accomplished by the various methods employed in cities and towns. Persons uninformed on such matters naturally presume that all water-works are alike; but you gentlemen are aware of the difference and therefore, in assembling as we do and discussing the different methods of management and construction, our minds are improved and we are better educated for the performance of our duties,

The great question in this country is that of *Pure Water* and it behooves us to endeavor to discover and pursue a line of thought and study that will transmit to our successors ideas tending to preserve the purity of our streams, especially in New England.

There are other questions which arise, of a hydraulic nature, which in our different systems produce results of great importance and untold benefit, when developed in a practical manner and communicated in meeting. Sanitary questions have been introduced and discussed, and during the past year able experts have given us the benefit of the results of intelligent and thorough research of this subject of the greatest concern for the health and mortality of populous settlements. In fact, any and all subjects in regard to which information is desired are considered to the best of our ability. I am happy to say that the interchange of sketches is growing in favor, a fact which will repay our former Committee which so earnestly advocated them. Our journal, issued quarterly, is I am told meeting with more than success, some gentlemen joining the association to find give the benefits of that alone, and who will occasionally meet with us in convention. The editors are entitled to great credit for their valuable work.

I think there is a feeling among all the members, to make the association what it is intended for, viz: a social exchange of practical results and not an advertisement for themselves, excepting only our associate members, who I am pleased to-day make an exhibit of their different devices with an energy and sociability only equalled by their persistence (*in some cases*) to make their goods so desirable and attractive, that one can hardly refrain from buying.

The association financially is in good standing and I trust we shall keep it so. You all have observed that any concern that has a good balance in the treasury with no unpaid bills, stands well in the community.

In conclusion I cannot help speaking of our associates who have passed away:—PHINEAS SPRAGUE died Sept. 14, 1887; THOMAS A. HODGE, died Dec. 16, 1887; HOSEA H. WHIDDEN died Jan. 3, 1888; SYLVANUS D. HORTON, April 19, 1888; ALBERT H. UPTON, June 8, 1888; all men of true worth; social, courteous and affable, and the positions they held showed the confidence that was reposed in them by their fellow-townsmen.

Mr. HORTON was my associate in business for the past 20 years and I mourn his loss like a brother and a life long friend.

The executive committee reported $888.31 on hand at present, or an excess of $416.11 over that of last year.

A paper entitled "Soils from which supplies of water may be obtained by filter galleries or driven wells," was then read and discussed. The President then appointed as a committee on blue prints, Messrs. SHERMAN and RICHARDS.

Invitations to visit various places of interest from S. M. GRAY, City Engineer, were also received and accepted unanimously, as was one from WM. E. RUSSELL, Mayor, Cambridge, Mass., to examine their system of water-works and extensions which have recently been made, on their "Outing day," July 4. Mr. W. P. WITTEMORE gave a "Description of apparatus for notifying when high water level is reached in reservoirs and water tanks," by means of a large drawing which was hung over the wall, and about which questions were asked and answered therefrom.

Mr. DARLING then stated that he had completed arrangements for a trip down the river on Friday, which, however was dependent upon the action of the members. Vote taken and carried that they should take the trip.

QUESTIONS AND ANSWERS.

The question was then asked by the President—"What is the best way to limit the use and weight of special castings?"

In reply to a request from the President, Mr. TIDD of Boston in substance stated: "From experience which I have had with special castings, and especially with some made by a firm in Glasgow, Scotland, I have come to the conclusion, that the best way to do is to specify in writing exactly the weights, signs, etc., of the castings, and then if there are any other than the specifications call for, reject the whole lot."

It was afterwards voted upon motion by Mr. FITZGERALD, that a committee be appointed, and the subject thoroughly investigated and reported upon.

The President then announced, that Prof. J. E. DENTON, of the Stevens Institute of Technology, Hoboken, N. J., would present a series of lantern views explanatory of the general hydraulic problems involved, and methods employed in the building of the new Croton aqueduct for the increase of the water supply of New York City, and requested that all members be present at 7.30. P. M.

The lecture presents lantern views of a map showing the location of the new aqueduct's source of water supply, and the routes of the new and old aqueducts, including a profile of the 30 miles of rock excavation forming the new aqueduct, and a cross section of the proposed mammoth Quaker Bridge dam, necessary to afford the desired extra storage capacity.

The general civil engineering features of the new aqueduct are explained, and then views given of the interior of one portion of the rock tunnel (of which the aqueduct mainly consists) illustrating the character of the ground excavated, and the methods of drilling, blasting and timbering employed.

Views of the several varieties of rock drills, and air compressors used in the work are given, and their respective characteristics and advantages discussed.

Tables and diagrams of tunnelling performance on the aqueduct are exhibited, and comparisons drawn from them with respect to the record of the great Arlberg tunnel, showing to what extent, and why, the greatest speed of tunneling on the aqueduct was far less than that attained at this famous Swiss tunnel.

THE Aqueduct Commissioners at their meeting on May 28 adopted a resolution authorizing and directing the President to prepare as soon as practicable a general review and report of the work of the commission during the years 1887 and 1888, which shall be a continuation of the second volume of his review and report heretofore published, date of Jan. 1, 1887. The review and report will include the history of all important action and proceedings of the Commissioners during said period and also the plans and work of construction of the new aqueduct, and its dams, reservoirs, and appurtenances; also, such plans and projects as are under consideration, but not fully perfected and adopted at the close of the year 1888, with such statistical information as the president may require. We trust this programme will be carried out. It will make a valuable work.

The profit sharing plan which has been in operation on the Toledo, Ann Arbor & North Michigan Ry. for more than a year, is said to be giving entire satisfaction to both stockholders and employés. In addition to his wages each employé is entitled to a share in the profits of the road, but runs no pecuniary liability in case of loss A certain amount of stock is to be conveyed absolutely to each employé who remains in the company' service 20 years.

All employés who may be disabled or lose their lives, while in the line of active duty, are entitled to an amount of stock which shall equal the wages paid them the year prior to their disability or death, which stock they or their legal representatives may sell as any other property. It is estimated that the cash dividends paid, in addition to the regular wages, will come from increased earnings, the result of care and economy on the part of employés.

CONSTRUCTION NEWS.

RAILROADS.

East of Chicago.

Existing Roads.

Chicago & Northwestern.—Tracklaying on the extension in the north Michigan peninsula is completed to Michigamme and will reach Republic by June 25.

New York, Mahoning & Western.—Dr. NORVAN GREEN has been elected President of this Ohio company and says:

"I believe that the company will have no serious difficulty in raising funds for the early completion of their line of road across the State of Ohio, eastward to the Pennsylvania line near Youngstown, and westward through Indiana as far as Fort Wayne."

"It is contemplated that this line of road shall form part of the long projected American Midland Railway from New York to Chicago on or near the Forty-First parallel, and on which much work has been done in various places."

Wheeling & Lake Erie.—It is reported that an agreement has been reached by the managers of this company with the managers of the South Pennsylvania & Ohio, by which the two companies will work in harmony in the construction of the railroad bridge across the Ohio river at Wheeling and the 40-mile extension of the Wheeling and Lake Erie.

Pittsburg, Shenango & Lake Erie.—The Erie, Shenango & Pittsburg has been consolidated with this company, and work is to begin at once at the extension from Amasa, Pa., to Lake Erie,

New Projects and Surveys.

Brantford, Waterloo & Lake Erie.—GEO. H. WILKES is President; THOS. ELLIOTT, Vice-President, and J. J. HAWKINS, Secretary of this Canadian company, whose headquarters are at Brantford, Ont. Contracts for grading are to be let soon.

Columbus, Lima & Northwestern.—It is again reported that work is to begin at once on this Ohio road.

Wharton Valley.—Incorporated in New York by WM. TALBOT, of West Burlington; JAS. E. CHILDS, of the New York, Ontario & Western R. R. Co., and others, to build a railway from New Berlin to Edmeston, a distance of 7 miles.

SOUTHERN

Existing Roads.

Louisville, St. Louis, & Texas.—Work was resumed on this road on May 1 and track is now laid from Owensboro to Hawesville, 28 miles. Work on the first division, West Point to Stephensboro, is under way and will probably be kept ahead of tracklaying. On the third division work is in progress at Green river. The coffer-dam for the pivot pier is ready to be sunk and framing on the dam for rest pier No. 1 has been commenced.

Norfolk & Virginia Beach.—This Virginia company contemplates the construction of a branch to Princess Anne Court House at a cost of about $200 000. CHAS. W. MACKEY, of Franklin, Pa., is President. T. O. TROY, of Norfolk, Va., is Superintendent.

Atlantic & Danville.—Surveys are in progress between Belfield and Danville, Va., and grading on this division is soon to begin.

Gulf & Ship Island.—Grading is making good progress on the southern division between Hattiesburg Miss., and the Gulf.

Carolina, Cumberland Gap & Chicago.—The Charleston, S. C., Board of Trade is endeavoring to raise $1,500 to pay for a survey of the route of this line between Pickens and Ashville, N. C.

New Projects and Surveys.

Chicago & Gulf.—A press dispatch from Hopkinsville, Ky., states that D. A. COURTER, the President of this company, is endeavoring to obtain a subscription from Christian county, Ky.

Jacksonville & St. Augustine Short Line.—This company has been incorporated in Florida by CHAS. WILLIAMS of Manchester, N. H., J. G. VAN TASSEL of New York City and others.

Tampa & Thonotassa.—This company has been organized at Tampa, Fla., LAMONT BAILEY is President, and S. B. TURMAN is Secretary.

Falls Church & Potomac.—Organized at Alexandria, Va., to build a railroad about 6 miles in length. R. MORRISON is President, N. F. GRAHAM is Vice-President, and E. A. GREENOUGH, Treasurer.

Memphis, Oxford & Columbus.—Surveys are to begin at once on this Mississippi road. The city of Columbus has just voted $100,000 in aid of the enterprise.

THE NORTHWEST.

Existing Roads.

Winona & Southwestern.—The old board of directors were reëlected at the recent annual meeting.

Illinois Central.—Surveys are reported in progress from a point opposite Yankton, Dak., to Norfolk, Neb.; but what the value of such a line would be to the Illinois Central is not stated.

Watertown & Lake.—A suburban motor line is under construction from Watertown, Dak., to Lake Kampeska.

Red River Valley.—Two engines for this road have arrived at Winnipeg from the Kingston locomotive works.

Chicago, Burlington & Quincy.—The chief officers of the system are reported as saying that no new construction will be undertaken this year west of the Missouri.

New Projects and Surveys.

Chicago, Oquawka & Kansas City—Mr. WALTER BROWN of Kansas City, the chief mover in this enterprise, has just retured from England and it is reported that he succeeded in marketing $11,000,000 worth of the company's bonds. The proposed line is to run from Kansas City to Oquawka, Ill.

Northern Minnesota.—This line is projected to run from Red Lake Falls, Minn., northwest to Emerson, Manitoba, about 95 miles. E. H. LOW, Hallock, Minn., is Secretary.

THE SOUTHWEST.

Existing Roads.

Texas & Pacific.—The branch to the Palo Pinto coal mines has just been completed. A large amount of new steel is being laid on the Rio Grande division.

Burlington & Missouri River.—The tracklaying is in progress on the extension across the northwest corner of Kansas, which was completed to Blakeman last year. The rumors that this line is intended to reach Pueblo, Col., seem not improbable.

St. Louis, Arkansas & Texas.—Right of way is being secured for the extension from Malden to Grand Tower, Mo.

New Projects and Surveys.

Nebraska & Southwestern.—Incorporated in Kansas to build about 500 miles of railway lines by GEO. G. BAILEY, ASA H. BRADSTRET and others of Atwood, Kan.

Emporia & Council Grove.—Incorporated in Kansas to build a railway from Greenwood north *via* Emporia to the State line, about 200 miles. W. H. WHITE of Council Grove is interested.

Lenora, Oberlin & Northwestern.—Incorporated in Kansas by F. D. MILLS of Atchison, CHAS. E. CHANDLER of Oberlin and others.

Russell & Southeastern.—Incorporated in Kansas to build a railway from Russell to Hutchison, 81 miles. CHAS. A. WALCOTT, of Russell, and S. E. HALL, of Salina, are interested.

Pine Bluff, Princeton & Arkadelphia.—This Arkansas company proposes a line from Pine Bluff to Arkadelphia. J. B. YORK is President, and J. B. RUTHERFORD is Secretary.

Galveston Jetty.—A project is on foot at Galveston, Tex., to build a railway direct to Shreveport, La.

Ruston & Columbia.—A meeting was recently held at Ruston, La., to consider the project for a railroad from that point to Columbia, on the Ouachita river, to connect with the Ouachita steamboats for New Orleans.

Kansas City, Monett & Southern.—Chief Engineer BOND is engaged on the locating surveys of the line between Monett, Mo., and Kansas City.

Denison & Choctaw.—Preliminary surveys are in progress for this line at Denison, Tex.

Galveston Air Line.—It is stated that a party of capitalists are making an examination of this Texas line with a view to advancing the funds for its construction.

Dallas, Archer & Pacific.—The railroad committee of the Dallas Board of Trade has issued a manifesto calling for aid to this company by the citizens of Dallas.

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

Denver & Scranton.—It is reported that this Colorado road is to be extended eastward from its present terminus 17 miles from Denver to the Kansas State line, nearly 150 miles. C. M. WICKER of Denver is General Manager.

Oregon Ry. & Nav. Co.—Work is reported in progress on the extension to the Cœur d'Alene mining district, under Carey Bros., contractors.

San Pete Valley.—A suit is in progress at Salt Lake City, Utah, against S. BAMBERGER, the former manager of this railway, in which it is alleged that BAMBERGER while in charge of the company's property stole rails, ties, rolling stock and funds enough to build the road known as the California Short Line Ry. The company sues to obtain possession of this line and $10,000 damages.

Denver, Texas & Ft. Worth.—J. R. DE REMER has the contract for a branch 19 miles in length from Trinidad, Col., up the Chriosa canon.

Laundry Farm.—Grading is in progress on this 5 mile suburban road at Oakland, Cal., under contractor S. B. Remington.

San Francisco & Northern Pacific.—The Marin & Napa extension has just been completed. It is about 7 miles in length. Work is making good progress on the Cloverdale & Ukiah line and about 18 miles are graded. It is expected to have the line in operation by Aug. 15. A rumor is in circulation that a branch is soon to be constructed into the Sacramento Valley, running from Sonoma Landing *via* Oroville to Beckwith Pass.

Denver & Rio Grande.—Surveys are in progress with a view to straightening and improving the line of the Eagle River, Aspen & Glenwood Springs branch. The directors of the company have concluded to postpone still further the payment of dividends.

New Projects and Surveys.

Mexican Pacific.—This company has filed articles of incorporation in New York and proposes to build a railroad from Tepic, Mex., to some point in the State of Sonora, with a branch to Topolobampo bay. The capital stock is $1,000,000. Among the incorporators are EATON N. FRISBEE, RÔBERT G. INGERSOLL, FREDERICK F. WOODWARD, WILLIAM WINDOM, ISAAC M. BROWER, all of New York; EDWARD O. HOBBS, of Brooklyn; JAMES S. NEGLEY, of Pittsburg, and N. NOBLE BETTS, of Tonawanda, Pa.

Monterey & Tampico.—C. S. MASTEN, of Phœnix, Ariz., is Chief Engineer and General Manager of this Mexican company.

Oregon Ry. Extension Co.—Incorporated in Oregon to build railway lines from Portland to Astoria, with a branch to Forest Grove. W. H. HOLCOMB is interested.

Northwestern Coal & Navigation Co.—This company is considering a proposed railroad from some point near Lethbridge, Alberta, N. W. T., to the International boundary to connect with a line from the American railway systems. The especial object of the line would be the transportation of coal to Montana mines.

Ocean Air Line.—This company has been incorporated at Los Angeles, Cal., by E. GERMAIN, A. J. HEALEY, and others to build a railroad 50 miles in length from Los Angeles to Long Beach.

Washington Short Line.—Incorporated at Tacoma, W. T., by A. C. MASON, F. A. SEARS, J. W. PINKERTON, and others, to build a line 5 miles in length.

Dodge City, Montezuma & Trinidad.—It is reported that an effort is to be made to secure a large subscription to this company at Trinidad, Col.

THE RAILWAY CONSTRUCTION OF 1887.

(Accompanying Map No. 9 of the Progress and Prospects of Construction).

The following list includes all the railway lines in the United States, Canada and Mexico on which track was laid during the calendar year 1887, which do business as common carriers of both freight and passenger traffic. For summaries of the work done on the principal systems see editorial pages:

Canada.

COMPANY.	MILES.
Baie des Chaleurs. Metapedia to Carleton	40.
Brockville, Westport & S. S. M. Lyn to Westport	40.
Canadian Pacific. Algoma to Sault Ste. Marie	86.
Montreal to Smith's Falls	129.1
Woodstock to London	27.
Glenaran to Wingham	5.
Port Moody to Vancouver	14.
Esquimalt & Nanaimo. Nanaimo to Wellington	5.
Grand Trunk. *(Beauharnois Junction).* St. Martine to Melocheville	10.
Intercolonial. Pictou to Stellarton	14.
Lake Temiscouata. Riv. du Loup to Edmundston	80.
L'Assomption. L'Epiphanie to L'Assomption	3.50
Long Sault & Temiscamingue (On upper Ottawa)	6.
Maccan & Joggins. To Joggins Mines	12.
Newfoundland. Harbour Grace Jc. south	12.
Niagara Central. Niagara Falls to Thorold	8.
Northern & Western. Blackville to Indiantown	9.
Pontiac & Pac. Junc. Coulonge to Ottawa river	10.
Quebec & Lake St. John. To Lake St. John	74.
Quebec Central. Dudswell Jc. branch	5.
St. Lawrence, L. L. & Saguenay. St. Tite Jc., north	22.5
Winnipeg & Hudson Bay. Winnipeg to Lake Manitoba	40.
Total (22 lines built by 18 companies)	662.1

Maine.

Canadian Pacific. Holeb Pond east	8.
York Harbor & Beach. Kittery to York Beach	11.27
Total	19.27

New Hampshire.

Upper Coos. No. Stratford to West Stewartstown.	20.
Total	20.

Vermont.

Clarendon & Pittsford. W. Rutland to Cen. Rutland	4.
Total	4.

Massachusetts.

Boston & Maine. Essex to Rockport	10.
Boston, Winthrop & Shore. At Winthrop	1.
Central Mass. Barre Plains to Northampton	40.
Chatham & Harwich. Chatham to Harwich	7.
Old Colony. Matfield to Easton	6.86
Total (5 lines built by 4 companies)	64.86

Connecticut.

Meriden & Waterbury. Meriden to Waterbury	18.
Total	18.

New York.

Carthage & Adirondack. Jayv'e to Little River	6.5
Chatauqua Lake. Jamestown to Mayville	23.
Chateaugay. Loon Lake to Saranac Lake	18.86
Elmira, Cortland & Northern. To Camden	5.
Grand Trunk. Ft. Covington to'd Massena Spr	15.
Long Island. To Far Rockaway	4.
New Jersey & N. Y. Garnerville to Haverstraw	2.37
New York Central. At Lewistown	1.2
Northern Central. At Canandaigua	1.43
Rome, Watertown & Ogdensburgh. At Rochester	1.
Total (10 lines by 10 companies)	78.36

New Jersey.

New Jersey Junc. Weehawken to Pa. R. R. Jc	5.08
Pennsylvania. Manumuskin to Maurice River	9.71
Branch in Salem	1.
Total (3 lines built by 2 companies)	15.79

Maryland.

Total (See West Virginia)	4.

Pennsylvania.

Bell's Gap, and Clearfield & Jefferson. Mahaffey to Horatio	21.5
Irvona to Frankhurst and two short branches	3.3
Bloomsburgh & Sullivan. Blooms'h to Benton	20.
Erie & Wyoming Valley. Dunmore to Scranton	2.
Lehigh Valley. Luzerne to Harvey Lake	12.7
Delano to Hazleton	13.
Highland to Sandy Run Jc	2.5
Pennsylvania. Junction to Nescopec	11.96
Frackville to Shenandoah	4.88
Branches to Mines, Etc	6.45
Phœnix Valley. Phœnix to Sunderlinville	4.5
Wilkesbarre & W'n. Washingtonv'e to Milly'e	11.2
Total (20 lines built by 8 companies)	116.99

Ohio.

Cin., Ham. & Dayton. Between Troy and Piqua	3.
Cin., Jack. & Macki. Cecil, O., to Addison, Mich	60.
Germantown to Carlisle and branches	8.5
Cleveland, Akron & Col. Killbuck to Dresden Jc.	33.4
Cleveland, Loraine & Wheeling. W. Wheeling to Bellaire and Bridgeport to Martin's Ferry	6.4
L. Shore & Mich. So'n. Dou'n Jc., O., to Sharon, Pa.	7.7
Louis've, Cin. & Dayton. Hamilton to Middlet'n	14.
Marietta, Col. & No'n. Amesville to Sharpesburg	5.
Pittsburg, Cin. & St. L. Red Bank to'd Hamilton	5.
Scioto Valley. In Portsmouth	5.
Zanesville & Ohio River. Malta to Waterford	26.27
Total (14 lines built by 10 companies)	146.77

Indiana.

Cin. & So'n Ohio. Lawrenceb'g to Aurora	4.
Evansv'e & Terre Haute. Saline City to Brazil	12.
Farmersburg to New Pittsburg	10.
Louisv'e, Evansv'e & St. Louis. Lincoln to Cannelton	46.7
Louisv'e, N. Albany & Chi. To French Lick Sp'r	5.71
Midland of Indiana. Lebanon to Ludoga	21.
Ohio & Miss. Watson to New Albany	7.5
Total (8 lines built by 7 companies)	84.91

Michigan.

Bear Lake & Eastern. To Maple Grove	4.5
Chicago & No'w'n. Iron River to Watersmeet	35.16
Mastodon to Dunn Mine	3.22
Chicago, Kalamazoo & Sagi. Kal. to Hastings	31.
Detroit, Bay City & Alpena. At Alpena	2.
Thompson to Potts	4.
Mud Lake and other branches	33.23
Duluth, So. Shore & Atlantic. Soo, Jc. to Sault Ste. Marie	46.75
Nestoria to 12 miles west of Dogwood	125.
Manistee & Luther. Branches and extension	22.75
Mich. Central. Pinconning to Gladwin	20.
Milwaukee & No'n. Iron Mtn. to Champion	55.84
Minneapolis, Sault Ste. Marie & Atlantic. Mich. State line to Sault Ste. Marie	192.
Toledo & So. Haven. Hartford to So. Haven	16.
Toledo, Ann Arbor & North Michigan. Ashley to Muskegon	95.8
Mt. Pleasant to Cadillac	68.
Total (22 lines built by 13 companies)	783.25

Virginia.

Atlantic & Danville. W. Norfolk to Suffolk	18.
Norfolk & Western. Foster Falls to Ivanhoe	8.03
Patterson, Flat Top and other branches	18.50
South Atlantic & Ohio. Benham to Big Cut	30.
Total (14 lines built by 5 companies)	54.53

West Virginia.

Kanawha & Ohio, Charleston, south	2.
Kingwood & Tunnelton. Kingwood to Tunnelton	11.
Ohio River. Point Pleasant to Guyandotte	40.
Pitts., Cinn., & St. Louis. To New Cumberland	8.04
W. Va. Cen. & Pittsburg. Thomas, west	2.
Bet. Piedmont, W. Va., and Cumberland, Md.	13.
Total, (6 lines built by 5 companies)	72.04

North Carolina.

Albemarle & Pantego. Mackey's Ferry to Roper's	4.
Atl. Coast Line. Rocky Mt. to Springhope	19.
Clinton to Warsaw	14.
Cape Fear & Yadkin Va. Below's Crk. to Pilot Mt.	32.
Marietta & North Ga. Ga. line to Murphy	13.35
Richmond & Dan. Oxford, N.C., to Clarkesville, Va.	25.00
Statesville to Taylorsville	20.

Jarrett's, west	1.5
Roanoke & Tar River, Boykins, Va., to Lewiston, N. C.	35.
Suffolk & Carolina, Bosley to Chowan	11.3
Total, (10 lines built by 7 companies)	165.05

South Carolina.

Atl. Coast Line, Pee Dee Jc. to Dillon	18.
Blackville, Newberry & Alston, Blackville to Sally's	17.
Charleston & Savannah, Ravenel's to Young's Island	6.
Charleston, Cinn. & Chicago, Camden, north	20.
Columbia & Greenville, W. Union to Walhalla	1.8
Palmetto, To Cheraw	2.
Wilmington, Chadbourn & Conwayboro, Loris to Conway	19.
Total, (7 lines built by 7 companies)	83.8

Georgia.

Americus, Preston & Lumpkin, Americus to Abbeville	61.7
Atlanta & Florida, Atlanta south	30.
Buena Vista & Ellaville, To Americus	3.
Cen. R. R. of Ga. Blakely to Chattahoochee river	14.
Covington & Macon, To Monticello	24.
Ga. Midland & Gulf, End 29th Mile to McDonough	69.
Ga. So'n & Fla. Macon to County line	10.
Rome & Decatur, Rome, Ga., west	15.35
Atalla, Ala., east	14 62
Savannah & Tybee, Savannah to Ocean City	17.75
Total, (9 lines built by 8 companies)	244.80

Florida.

Atlantic & W'n, Lake Helen to New Smyrna	20.
Florida Midland, Ocoee to Wayco	7.
Fla. Ry. & Nav. Co. Withlacoochee river to Plant City	40.
Jacksonville & Mayport, Arlington to Mayport	15.
Orange Belt, Oakland to Tarpon Springs	85.2
Pierson, Kenwood & Palmetto, Pierson to Palmetto	3.
Southern Fla. Tampa to Black's Point	10.
Silver Spr., Ocala & Gulf, Leroy to Dunnellon	17.
Tavares, Apopka & Gulf, To Minneola	19.
Total, (9 lines built by 9 companies)	216.2

Alabama.

Cen. R. R. of Ga. Bet Goodwater and Birmingham	40.
East Ala. Buffalo to Roanoke	17.5
East & West Ala. Broken Arrow to Pell City	7.
Georgia Pac. Coalburg to Cane Creek	39.4
Woodlawn to Bessemer	18.75
Kan. Cy., Memphis & B'ham. To Birmingham	105.
Louisville & Nashville (*Birmingham Mineral*) Redding to Boyles and Ensley City	24.
Bessemer to Woodstock	25.
Mobile & B'ham, Jackson to Turkey Creek	48.
Marion Jc. to Wilson	24.
Montgomery & Fla. McLaren's Mills, south	20.
Sheffield & Birmingham, Russellville, south	33.
Talladega & Coosa Valley, Stemley to Pell City	9.
Tenn. & Coosa River, Attala to Littleton	6.
Total (15 lines built by 12 companies)	464.27

Mississippi.

Gulf & Ship Isl'd, Cotton Plant to Pontotoc	25.
Gulfport to Biloxi River	11.
Kan. Cy. Mem. & B'ham. Tupelo to Ala. line	41.
Amory to Aberdeen	12.
Total (4 lines built by 2 companies)	89.

Tennessee.

Danville & La Grange, Danv'e to S'tribling	6.
Louisv'e & Nashv'e, St. Joseph to Ironton, Ala.	12.
Nashv'e, Chatt. & St. L. Victoria to Dunlap	18.
Elora, Tenn., to Huntsville, Ala	27.
Tenn. Midland, Jackson west	15.
Total (5 lines built by 4 companies)	45.

Kentucky.

Charleston, Cinn. & Chicago, Richardson to White House	8.
Louisville & Nashv'e, Bardstown to Springfield	20.
Corbin to Barbourville	16.
Near Newstead to Cerulean Springs	21.
Louisville Southern, Bet. Louisv'e & Harrodsb'g	18.
Maysvill & Big Sandy, Ashland to Tygart Creek	28.
Maysville, east	23.
Newport News & Miss. Va. Elizabeth'n to Hodgdenville	11.
Ohio Valley, Sturgis to Princeton	44.7
Morganfield to Uniontown	6.5
De Koven to Ohio River	2.
Total (10 lines built by 6 companies)	198.2

Illinois.

Chicago & Eastern, Ill. Sidells' to Tuscola	27.
Chicago, Burl. & Q. Bet. Walnut Jc. & Streator	26.
Chicago, Santa Fé & Cal. Ft. Madison to Ancona	135.
Elgin, Joliet & E'n Ind. Kings Jct. to'd Spaulding	10.
Illinois Cen. Freeport to Rockford	28.
Jacksonville So'e'n, Centralia to Driver's Sta.	17.9
Lake Erie & W'n. Bet. Bloomington & Peoria	22.8
Mich. Cen. Hammond, Ind., to So. Chicago	5.
Chicago, St. Paul & Kan. City, Dunbar (near Freeport) to Aiken (near Galena)	49.59
Pitts. Ft. Wayne & Chic. Colehour to C. St. L. & P. Jc.	4.36
Hegewisch, Ill., to Hammond, Ind	2.60
St. Louis, Alton & Terre Haute, Marion to Parker City	15.
St. Louis & Chicago, Litchfield to Mt. Olive	10.
Total (15 lines built by 12 companies)	365.75

Wisconsin.

Chicago, Milwaukee & St. P. Mather No'west	9.
Albany to New Glarus	16
Merrill to Minocqua	54.
Chicago, St. P., Minn. & O. To Neillsville	1.34
Ill. Cen. Buena Vista, Ill., to Madison, Wis.	61.5
Cedarville, Ill., to Blanchardville, Wis.	35.
Milwaukee, Lake Shore & W'n. Hurley branch	6.5
Minn. S. Ste. M. & Atl. Rhineland to Mich. line	85.
Minneapolis to Turtle Lake	73.
Godfrey Jc. to St. Croix	4.
Sault Ste. Marie & So'w'n. Fairchild to Osseo	14.
Wisconsin Central. Mellen to Bessemer, Mich.	33 62
Total. (12 lines built by 7 companies)	371.46

Minnesota.

Chic, Mil. & St. P. Hopkins to Lake Minnetonka	8.
St. Paul & Duluth. Thomson to Grassy Point	15.5
St. P. Minn. & Man. Benson Minn. to Wat'n Dak	92.21
Tintah Jct. to Evansville Jct	32.
Wis., Minn. & Pac. Eagle Lake to Mankato	10.
Total (5 lines built by 4 companies)	122.36

Dakota.

Chicago & No'w'n. Faulkton to Gettysburg	41.45
Verdon to Groton	14.46
(*F. E. & Mo. Va*) Rapid City to Whitewood	36.4
Chic. Mil. & St. P. Lake Preston to Bristol	73.
Roscoe to Eureka	26.
Chic., St. P., Minn. & O. Salem to Mitchell	32.8
Minn. & Pac. Lidgerwood to near Ellendale	69.5
Northern Pac. Grand Forks to Pembina	96.2
La Moure to Edgely	21.2
St. P., Minn. & Man. Near Minot to Mont. line	150.
Moorhead to Wahpeton	43.
Rutland Junction to Ellendale	49.
Rugby Junction to Bottineau	37.89
Park River to Langdon	40.
Total (17 lines built by 7 companies)	792.25

Nebraska.

Burlington & Mo. R. Central City to Arcadia	70.
Palmer to Burwell	69.
Greely Center to Ericsson	17.
Orleans to Kansas line	60.
Anselmo west	150.
Curtis to Colorado line	85.
Ashland to Schuyler	50.
Chicago & Northwestern. (*F. E. & Mo., Va.*) Linwood to Geneva	77.
Irvington to Omaha stock yards	10.3
Lindsay to Oakdale	53.2
Platte River Junction to Hastings	119.6
Chic., Kan. & Neb. Near Pawnee Cy. to Nelson	115.1
Fairbury to Kansas State line	15.
No Pac. Warwick, Kan., to Lawrence, Neb	35.
Auburn Junction to Weeping Water Junction	43.
St. Jos. & Grand Island. Sutton to Stromsburg	44.5
McCool Junction to 2½ miles east of Powell's	43.5
Alma to 2 miles west of Fairchild	85.2
Union Pacific. To Nantasket	0.7
Total (19 lines built by 6 companies)	1,133.1

Iowa.

Chicago & Northwestern. Kingsley to Moville	9.
Chicago, Mil. & St. Paul. Kansas City extension	40.
Between Sioux City and Manilla	13.
Chic., St. P. & Kan. Cy. Des Moines to Mo. line	97.6
Illinois Central. Cherokee to Sioux Falls., Dak.	96.
Cherokee to Onawa	58.7
Manchester to Cedar Rapids	41.7
Webster Cy. & So'w'n. Webster Cy. to Border Pl.	18.
Total (7 lines built by 6 companies)	369.0

Missouri.

Atch., Top. & S. F. Atchison, Kan., to St. Jos.	20.4
(*St. L., K. Cy. & Col.*) Valley Forge to Union	36.1
Cape Girardeau & Southw'rn. Brownwood br.	9.
Wappapello to Wellsdale	3.5
Chic., S. F. & Cal. Kan. Cy. to Ft. Madison, Ia.	226.
Central Mo. St. Charles, west	10.
Chicago, Mil. & St. P. Iowa line to Kansas City.	140.
Chicago, St. P. & Kan. Cy. Iowa line, southwest.	46.
Kan. Cy., Ft. S. & Gulf. Willow Spr. to Grandin.	29.
Kansas City, Ft. Smith & So'n. Neosho, south	6.
Mo. Pac. Between Lexington and Boonville	27.
Between Kansas City and Paola, Kan.	14.
Tower Grove to Carondelet	6.3
St. Louis & San Francisco. At Springfield	3.18
Total (14 lines built by 11 companies)	554 98

Kansas.

Atch., Topeka & Santa Fé. Alexander to Crosby.	91.7
Augusta to Mulvane	20.8
Hawthorne to Wilder	46.2
Carnatyne to Englewood	86.6
Girard and Frontenac extensions	7.4
Gladstone to Bazar	7.2
Burlington to Gridley	11.1
Neosho Falls to Yates Center	14.1
Coyville to Madison	28.3
Strong City to Concordia	123.75
Manchester to Barnard	43 20
Abilene to Salina	22.25
Brown's Grove to Jetmore	23.
Medicine Lodge to Lake City	22.9
Burl. & Mo. R. Nebraska line to Blakeman	35.
Chicago, Kan. & Neb. Holton to Kingsdown	294.
Nebraska line to Norton	139.
Herington to Caldwell	124.
Herington to Salina	60.
McFarland to Bellevill	104.
Dodge City to Bucklin	26.5
Kansas City & Pacific. Parsons to Selma	61.
Kansas City, Wyandotte & No'w'n. To Seneca	106.
Missouri Pac fic. Corwin to Kiowa	8.
Leroy to Madison	25.
Turon to Larned, and Cedarvale to Belle Pl.	124.
Olcott to Iuka	20.
Monon to Great Bend	10.
Gypsum City to Marquette	27.
Dexter to Arkansas City	25.
Geneseo to Kanopolis	14.
Between Geneseo and Hutchinson	27.
Templeton to Colo. line	138.
St. Louis & San F. Wichita to Ellsworth	104.15
Pittsburg to Weir City	8.81
Union Pacific, Oakley to Colby	25.
Lincoln Center to Waldo	35.3
Total (37 lines built by 8 companies.)	2,101.66

Indian Territory.

Atch., Top. & Santa Fé. Alva to Texas line	102.9
Mendota to Purcell	98.3
Red River to Purcell	107.
St. L. & San. F. Bet. Ft. Smith, Ark. and Paris, Tex.	113.32
Total (3 lines built by 2 companies.)	408.20

Arkansas.

Missouri Pacific, Bet. Bald Knob & W. Memphis	64.
St. Louis & San Fran., Jenson to Mansfield	18.34
Fayetteville to St. Paul	33.29
St. Louis, Ark. & Texas, Lewisville to Hanfield	13.
Altheimer to Quapano Lake	9.
Total (5 lines built by 3 companies.)	137.63

Louisiana.

East Louisiana, Pearl River to Abita Springs	16.
Natchitoches, Prudhomme to Natch	11.
New Orleans & Gulf, Poydras to Bohemia	35.
Total	62.

Texas.

Atch., Top. & S. Fé. Ind. Ter. line to P'handle City	95.8
Ladonia to Paris	31.
Cleburne to Weatherford	40.
Denison & Washita, Va. Denison to Red River	6.
Ft. Worth & Denver, Chillicothe to N. M. line	262.
Ft. Worth & Rio Grande, Ft. Worth to Granbury	40.2
Missouri Pacific, Bastrop to New Ulm	55.
Gainseville to Henrietta	69.9
San Marcos to Stockholm	16.
St. Louis, Ark. & Texas, Commerce to Remer	57.
Corsicana to Hillsboro	40.
Near Mt. Pleasant to Sherman	110.
San Ant. & Aransas Pass, San Ant. to Kerro'e	70.5
Cuero to Wallis	20.5
Yoakum to West Point	49.1
Tex., Sabine Va., & No'w'n. Tatum to Beckville	6.45
Total (17 lines built by 9 companies.)	1,052.77

Wyoming.

Chic. & No'w'n. (*F. E. & Mo. Va.*) Douglas to Glen Rock	28.9
Chicago, Burlington & Quincy, Colo. line to Cheyenne	12.
Union Pacific, Cottonwood to Douglas	70.
Total	110.9

Montana.

Northern Pacific, Coal Spur to Cokedale	3.6
Jefferson Junction to Galvin	30.
Clough Junction to Marysville	12.5
Drummond to Philipsburgh	25.8
Missoula south	40.
St. Paul, Minn. & Man. Dak. line to Great Falls.	400.
Great Falls to Helena	98.3
Union Pacific, Branches to Mines	5.84
Total (9 lines built by 3 companies.)	616.04

Idaho.

Coeur d'Alene, Wardner Jc. to Burke	19.5
Idaho Central, Nampa to Boise City	20.
Total	39.5

Washington Territory.

Northern Pacific, Belmont to near Colton	47.
Seattle, Lake Shore & Eastern, Seattle to Kelsey's	28.
Total	75.

Oregon.

Oregon Pacific, Albany east	20.
Portland & Will. Valley, Elk Rock to Portland	5.8
Total	52.1

California.

Altadena, Raymond to Altadena	7.
Atch., Top. & S. Fe. (*Cal. Cen.*) San Bernardino to Los Angeles	60.4
Arlington to Santa Ana	33.5
Santa Ana to near San Juan	24.4
S. B. & S. D. Jc. toward San Juan	1.
Escondido Jc. to Escondido	21.2
Los Angeles to Port Ballona	18.0
San Bernardino toward Mentone	6.9
Nevada & Cal. Chat to Camp Ham	8.
Nc. Pac. Coast. Ingram's, north	2.
Pac. Coast. Los Alamos to Los Olivos	14.
San Diego, Nat. Cy. & Otay, San D. to Oneonta	16.45
National City to Sweetwater Dam	6.02
So. Pac. Fillmore to Elwood	68.
Gazelle to Ore. line	42.
Ashland, Ore. to Cal. line	26.3
Tracy to Newman	37.1
Napa Jc. to Napa river	3.
Fresno to Locan	7.
Total (18 lines built by 6 companies)	375.97

Utah.

Union Pac. Summit to Syracuse	5.85
Total	5.85

Colorado.

Atch., Top. & S. Fe. Pueblo to Denver	116.8
Clelland to Canon City and branches	9 9
Burl. & Mo. R. Cheyenne extension	157.
Colo. Midland, Manitou to Glenwood Spr.	215.
Aspen Jc. to Aspen	19.
Cardiff to Jerome Park	16.5
Denver & Rio G. El Moro to Trinidad	4.
Rock Creek to Glenwood Spr.	64.29
Glenwood Spr. to Aspen	42.
Montrose to Ouray	36.
Leadville-Ryan Cut-off	3.2
Denver, Tex. & Ft. Worth, Trinidad, south	12.
Mo. Pacific, Kan. line to Pueblo	153.
Silverton & Red Mt'n, Silv. to Chattanooga	6.
Union Pac. Loveland to Buckhorn	8.3
Total (17 lines built by 8 companies)	863.74

Arizona.

Ariz. Mineral Belt, Flagstaff to Fulton Canyon	36.
Maricopa & Phœnix, Maricopa to Phœnix	34.95
Total	70.95

Mexico.

Mexican Cen. Irapuato to'd Guadalajara	61.
Mexican Nat. Saltillo, south	10.
Mexican Internat. Castano to Torreon	223.74
Total	294.74

Proposals Open.

Artesian Well.—About 1,000 or 2,000 ft. deep. THE CITY CLERK, Uniontown, Ala.

Sewers.—About 1,609 ft. of 3-ft. and 494 ft. of 2-ft. brick sewer. S. C. SLAYMAKER, City Engineer. GEO. W. PINKERTON, Clerk, Street Committee, Lancaster, Pa. June 18.

Paving.—Cedar block, brick or cypress. F. A. BURKE, City Clerk, Council Bluffs, Ia. June 18.

Dredging.—In Hudson river; 3,000 cu. yds. at Bath shoal, 7,000 cu. yds. at Kellogg shoal, 12,000 cu. yds. at Fish House shoal, 6,000 cu. yds. at Washington bar, 10,000 cu. yds. at Van Buren bar. JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y. June 20.

Sidewalks.—Constructing and repairing. HENRY FLAD, President, Board of Public Improvements, St. Louis, Mo. June 21.

Street Work.—Curbing and flagging. ERNEST ADAM, City Surveyor, Newark, N. J. June 21.

Street Work.—Regulating, grading, curbing and flagging. THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers Street, New York City. June 22.

Sewers.—Main sewer and branches. C. F. LANE, Village Clerk, Berea, O. June 23.

Bridge.—Stone arch bridge. ALBERT F. NOYES, City Engineer, Newton, Mass. June 23.

Electric Light Plant—Arc plant for lighting streets, alleys and public buildings; 100 arc lights of 2000-candle power; 4 towers; building, engines, dynamos, wires, lamps, masts, etc. WM. G. WHIPPLE, Mayor, Little Rock, Ark. June 25.

Embankment.—For low-service conduit; 90,000 cu. yds. earth embankment; 5,000 cu. yds. earth excavation; 125 cu. yds. brick masonry; 100 lin. ft. 48-in. iron pipe culvert, and laying; 180 lin. ft. 24-in. clay pipe culvert, and laying. HENRY FLAD, President, Board of Public Improvements, St. Louis, Mo. June 25.

Erecting Electric Light Plant.—HENRY FLAD, President, Board of Public Improvements. St. Louis, Mo. June 25.

Sewer.—About 460 ft. of 3 × 4 ft. brick sewer. HENRY FLAD, President, Board of Public Improvements, St. Louis, Mo. June 25.

Bridges.—Two iron bridges; length of bridge, 360 ft.; length of each span, 180 ft.; 18 ft. roadway, no sidewalk; capacity, 80 lbs. per sq. ft. JOHN HILLER, Engineer, Dayton, O. June 26.

Water-Works.—Complete system at Chadron, Neb. A. A. RICHARDSON, Consulting Engineer, Lincoln, Neb. June 26.

Bridges.—Three single span iron bridges; 150 ft., 75 ft. and 55 ft. clear between abutments; 16 ft. roadway. Bidders to furnish strain sheets and detailed drawings. A. J. WARD, Clerk of the Commissioners of Venango Co., Franklin, Pa. June 29.

Water-Works.—Wind engine, tank and pipe. L. E. CREWS, Town Clerk, Culbertson, Neb. July 1.

Water-Works.—For Bound Brook. Engineer, ISAAC S. CASSIN, of Philadelphia. JOS. M. THOMPSON, President, Bound Brook Water Co., Bound Brook, N. J. July 1.

Public Building.—At Augusta, Ga. W. A. FRERET, Supervising Architect, Treasury Dept., Washington, D. C. July 2.

Jail.—County jail; bids for cell work and jail house separately or for work complete. Proposals, plans and specifications are invited. C. E. GAY, County Clerk, Starkville, Miss. July 2.

Bridges.—Ten bridges. J. M. DODGE, Clerk of County Supervisors, San Diego, Cal. July 5.

Sidewalk.—Curbing and brick. THE CITY ENGINEER, Roanoke, Va. July 6.

Court House.—First story of Brown Co. court-house, at New Ulm, Minn. Architect, C. F. STRUCK, 129 Nicollet Ave., Minneapolis, Minn. E. C. KOCH, Chairman, County Commissioners, New Ulm, Minn. July 24.

Bridge.—Proposals, with plans, specifications and strain sheets for bridge across Willapa river; span, 145 ft.; approaches 225 and 320 ft. E. B. WOOD, Oysterville, Pacific Co., Washington Ty. August 6.

Bridge.—Low truss iron bridge, single span, 68 ft. total length, 12 ft. roadway, no sidewalk, capacity 100 lbs. per sq. ft. ISAAC DUNN, Auditor, Canneiton, Perry Co., Ind. August 6.

Bridges & Canals.

Columbia River Boat Railway.—Senator MITCHELL'S bill providing for a survey of the rapids of the Columbia river, (Oregon) at The Dalles and Celilo, with a view to the construction of a boat railway, and appropriating $500,000 for the commencement of work, has passed the Senate. In view of the fact that the bill may not pass the house as a separate measure, the Oregon senators will endeavor to get some suitable provision in the river and harbor bill for the commencement of the work.

Trent Valley Canal.—The Trent Valley Canal Commission has been hearing evidence at Toronto, Canada, with reference to the proposed canal, which, when constructed, will connect the Georgian Bay with Lake Ontario. The proposed route is from Waubousbene, on the Georgian Bay to Trenton on the Bay of Quinte, passing through Lake Couchiching, Lake Simco, across the country to Balsam Lake, to Cameron's Lake to Sturgeon Lake, to Stony Lake down the Otonabee river to Rice Lake to Meyer's Lake to Wilson's Lake and thence down the Trent river to the terminus at Trenton, the Canal lakes in Orillia, Fenelon Falls, Lakefield, Peterboro and Campbellford.

Graving Dock.—The Dominion government will build a graving dock at Kingston, Ont., at a cost of about $500,000.

A Large Drawbridge.—The new drawbridge of the San Francisco & North Pacific road across Petaluma Creek is completed. The draw is one of the largest of its kind in the United States. The bridge itself is 3,100 ft. in length, the draw being 226 ft. long, and the base 10 ft. above the water line. The draw weighs 125 tons, can support a load of 290 tons and rests on piles incased in iron.

Atlantic & Gulf Ship Canal.—Mr. CAFFAL, Chief Engineer, has been directed to continue the survey of this Florida peninsula canal from the mouth of Rice creek, on the St. John's river, to St. Augustine.

The Longueuil Bridge.—M. HENRI MALINGRE, architect, has forwarded to the railway commission at Ottowa the plans he had been requested to prepare by the town council of Longueuil for the proposed bridge across the river opposite the city. If a favorable opinion is received from the commission a joint stock company will be formed for the construction of the bridge. According to the plans the structure will be a very large one and it will cost about $2,000,000. It will begin at point St. Charles, and with a gradual ascent will span the main channel, 60 ft. above the low water level, and with a gradual descent will cross St. Helen's Island ending on the Government common on the south shore above the town of Longueuil. It will be of iron and will be wider than the Brooklyn bridge, which is 80 ft. wide. Upon it will pass the cars of the South Shore lines, street railway cars, vehicles and foot passengers. It will not obstruct navigation.

Bridge Notes.—*Greenville, Mass.* The new iron bridge over Green river, for the Fitchburg R. R., is about completed. Another bridge is to be built for the same road at Bardwell's.

Port Chester, N. Y.—The Governor has signed the bill authorizing GEO. H. LOUNSBURY to construct a bridge.

Lyons, N. Y.—A lift bridge is to be built over the canal. The work has been authorized.

Sandy Hill, N. Y.—A bridge is to be built at Ferry St.; the bill has been signed by the Governor.

Rochester, N. Y.—A special committee of the Common Council has been appointed to consider the matter of the location of the river bridges to be built with the $300,000 which the Board of Aldermen has been authorized to expend for this purpose.

Norfolk, Va.—The Norfolk & Western R. R. Co. will build a new bridge across the Eastern branch of the river; the plans have been approved by the Harbor Commission.

Memphis, Tenn.—The Mississippi bridge will be built by engineers MORISON and CORTHELL.

Nashville, Tenn.—Work is progressing on the piers of the Hyde's Ferry bridge and the erection of the superstructure will be commenced in July.

Manchester, Ala.—The Louisville & Nashville R. R. Co. will build a bridge over the Tennessee river for the Huntsville extension.

Demopolis, Ala.—The House, at Washington, D. C., has favorably reported the bill authorizing the Birmingham, Selma & New Orleans R. R. Co. to build a bridge across the Tombigbee river between Point Jackson and Demopolis.

Armourdale, Kan.—The new bridge at 24th St., which will cost $70,000, will be built this summer. It is proposed to build a viaduct on the south side of the river over the Santa Fé tracks.

Omaha, Neb.—At Washington, D. C., the House has passed the bill authorizing the construction of a bridge over the Missouri river.

Glenwood Springs, Col.—Work will be commenced shortly on the Denver & Rio Grande bridge, the abutments and pier of which were built early in the spring.

Dallas, Tex.—The County Commissioners will build 7 or 8 bridges in Dallas Co.

Los Angeles, Cal.—The City Trustees will have an iron bridge built across the river at Downey Ave. It will be 60 ft. wide and will be crossed by the cable railway.

Contracting.

Court House.—The contract for the court house at Ouray, Col., has been awarded to M. Carney, of Ouray, for $23,000. The architects are F. E. EDBROOKE & Co., of Denver, Col.

Asphalt Paving.—For the asphalting of Brattle Square and portions of Harrison Ave., Boston, Mass, only one bid was received by JOHN W. MCDONALD, Superintendent of Streets: Barber Asphalt Paving Co., Washington, D. C. (Charles Harris, Boston agent), $3.50 per sq. yd.

Granite.—The Waldoboro Granite Co., of Waldoboro, Me., has the contract for granite for the culverts of the Limerock R. R. at Rockland, Me.

Steel.—Andrew Carnegie, of Pittsburg, Pa., has the contract for the steel plates for the U. S. S "Maine."

Water Tower.—At Cedar Falls, Ia., the Water-Works Committee has rejected all the bids for the water tower as too high. J. H. JEFFERS is Chairman of the Committee.

Water-Works.—*Eureka, Kan.*—The contract has been let to S. K. Felton & Co., of Omaha, Neb., at $37,000, for the construction of water-works complete, according to plans and specifications prepared by J. W. NIER, C. E., of Kansas City, Mo.

Track Material.—New or second hand rails (35 lbs.), splice bars, spikes, bolts, etc., for 6 miles of track, are wanted by W. A. Burgess, of Greensboro, N. C.

Instruments and Office Supplies.—JOHN D. MOSS, C. E., has taken charge of the engineering and street improvement department of the city of Athens, Ga., and is desirous of fitting up his office with the best appliances and materials for a draughtsman and engineer. He solicits catalogues and prices of instruments, materials and office fittings; also of photographic materials. Samples of drawing and tracing papers are also requested.

Street Work.—The Board of Public Works, Duluth, Minn., has awarded the contract for granite curbing and concrete foundation on Superior St., to Wolf & Truax, at the following prices: 18, 20 and 24-in. granite curb, $1.44, $1.54 and $1.74 per lin. ft.; 3-in. tile drain, 5 cts. per lin. ft.; beach gravel, $1.30 per cu. yd.; earth and rock excavation, 40 cts. and $1.80 per cu. yd.; concrete, $6.30 per cu. yd.; masonry, $5 per cu. yd.; relaying curb, $1 per ft.; excavating and removing culvert, 60 cts. per cu. yd.; cast-iron, 5 cts. per lb.; total, $79,383.——Cedar block paving; the following proposals have been received: Wolf & Truax, 87 cts. per sq. yd.; A. J. McBean & Co., 93 cts.; Youngren & Gleason, 97 cts.; R. T. Wilson, $1.02; C. L. Snyder, $1.03; Thos. Reiley, $1.09; J. S. Wolf & Co., $1.30; the contract was awarded to Wolf & Truax.——Wm. B. FULLER is City Engineer.

Pier Work.—The Department of Docks, New York City, has received the following proposals for removing part of the old pier and building a new one at the foot of North Moore St., North River: Joseph H. Cofrode, $30,900; Ranald Gillies, $31,950; John W. Flaherty, $33,312.50; Pacific Improvement Co., $33,500; P. Sanford Ross, $34,409; R. P. Staats, $34,743; Joseph Walsh, $36,400; Bartholomew S. Cronin, $41,000. The contract was awarded to Joseph H. Cofrode.

Cable Cars.—J. G. BRILL & Co., of Philadelphia, Pa., have the contract for 30 large cars for the Pittsburg Traction Co., of Pittsburg, Pa. They will be 28 ft. long and have a capacity of 70 passengers.

Pumping Engine.—The following proposals for a pumping engine of 5,000,000 galls. daily capacity, at the Clifton Ave. station, have been received by the Aqueduct Board, Newark, N. J.: H. R. Worthington, New York, $17,970 for a low duty and $23,500 for a high duty engine; National Iron Works, $18,000 and $22,000, and $22,500; Geo. F. Blake Mfg. Co., New York, $23,000, $23,700, $20,500, $17,500; Archibald Young, $33,600; Davidson Steam Pump Co., New York, $19,600; Holly Mfg. Co., Lockport, N. Y., $23,500; Gordon & Maxwell, Hamilton, O., $24,500.

Public Building.—At Springfield, O., the contract for the construction of the market house and city building has been awarded to Ross & Hullinger, at $93,504.85.

Embankment.—The following proposals for 3,650 cu. yds. of gravel filling, and 500 cu. yds. of rip-rap, for the Charles river embankment at the end of West Boston bridge, were received June 8 by the Park Department, Boston, Mass.: John T. Scully, Boston, filling, 70 cts. per cu. yd.; rip-rap, $1.40 per cu. yd.; total $3,250; Boynton Bros., Boston, 75 cts., $1.21, $3,352; Charles H. Edwards, Quincy, 98 cts., $1.48, $4,317. The contract was awarded to John T. Scully.

T. William Harris & Co., engineers and contractors, of New York City, have added to their business a department of equipment and supply, and have arranged with Mr. HENRY H. MANSFIELD, formerly with Barrows & Co., to manage this department. They propose to furnish all kinds of supplies and equipment to parties interested in railroads, street railways, mines, rolling-mills, water and gas works.

Lead Pipe.—The following proposals for 35,000 lbs. of lead pipe have been received by the Executive Board, Rochester, N. Y.: N. Corwith & Co., Chicago, $3.95 per 100 lbs.; Behr & Steiner, New York, $3.95; Rochester Lead Works, $4.05; Everett & Post, Chicago, $4.15; Chas. Wagner, St. Louis, $4.17.

Cedar Block Paving.—At Lincoln, Neb., complaint is being made as to the way in which the cedar block paving is being laid. The contract calls for 2 galls. of hot tar composition per sq. yd., poured into the spaces between the blocks, but it is said that very little tar is used, the contractor saving a few cents per square yard and the city being injured to the extent of 40 or 50 cents, as the composition is essential to the life of the pavement. The proper way is to sweep coarse gravel into the spaces before pouring in the composition.

Grading.—The following proposals for grading Commonwealth Ave. have been received by JOHN W. McDONALD, Superintendent of Streets, Boston, Mass.: Charles Linnehan, Boston, $1.45 per cu. yd.; Patrick, O'Riorden, Charlestown, $1.57; John Coleman, Brighton, $1.59; Wm. Whittaker, Boston, $2.40 The contract was awarded to Chas. Linnehan.

Sewers.—The Board of Public Works, Duluth, Minn., has rewarded contracts as follows:—Sewer and appurtenances; Sang Bros.; rock excavation, $4.20 per cu. yd.; earth excavation, 90 cts. per cu. yd.; 10-in. pipe, 45 cts. per ft.; manholes, $80; lampholes, $14; inlets, $1.95; total, $1,945.60.——Sewer and appurtenances: C. Graveson; earth and rock excavation, 82 cts. and $3 per cu. yd.; 8, 9 and 10 in. pipe, 28, 37 and 40 cts. per lin. ft.; inlets, $1.60; flushing tanks, $15; manholes, $75; lamp holes, $13; concrete, $3 per cu. yd.; total, $5,068.10.——Portland cement concrete sewer; J. S. Wolf & Co.: earth and rock excavation, 80 cts. and $3 per cu. yd.; 28 and 32 in. sewer, $3.50 and $3 60 per lin. ft.; pipe sewer, 50 cts. per ft; manholes, $80; catch basins, $55 and $65; timber, $20 per 1,000 ft. B. M.; total, $5,931.——Storm sewer and street improvement, Zimmerman & Moore; earth and rock excavation, 35 cts. and $1.50 per cu. yd.; gravel, 95 cts. per cu. yd.; timber, $18 90 per 1000 ft. B. M.; 15, 18 and 24 in. pipe in concrete, $1.25, $1.60 and $2.48 per lin. ft.; 10-in. pipe in sand, 45 cts.; 3 ft. brick sewer, $4 per ft.; catch basins, $30; earth and rock excavation for sewer, 71 cts. and $3 per cu. yd.; manholes, $50; total, $21,761.20.——Brick storm sewers: M. H. Fitzpatrick; earth and rock excavation, $1 and $5.75; 40-in., 45-in., 44-in., and 48-in. sewer, $9.25, $6, $9.60 and $10 per ft.; 10 and 18-in. pipe, 50 cts. and $1; catch basins, $80 and $90; manholes, $90; total, $35,949.——Pipe storm sewers and street improvement; Wolf & Truax; earth and rock excavation, 32 cts. and $1.70; timber, 19 per M; gravel and rolling, 85 cts. per cu. yd.; 12, 20 and 24 in. pipe in concrete, $1 82 and $2 50; 10 in. pipe in sand, 45 cts.; manholes, $65; catch basins, $55; earth and rock excavation for sewer, 67 cts. and $4; removing earth, 27 cts. per cu. yd.; total, $24,329.——Pipe storm sewers in concrete; Youngren & Glea on; earth and rock excavation, 87 cts. and $5.28; 15, 18, 21 and 24-in. pipe in concrete, $1.12, $1.41, $1.80, $2.28 per ft.; 10 and 18 in. pipe in sand, 45 and 90 cts.; manholes, $44.40; catch basins, $48.48, $50.76, $69.96; timber, $22 per M; total, $22,073.84.—— WM. B. FULLER, City Engineer.

Shore Protection.—Proposals will be received until July 2, by Capt. F. A. MAHAN, U. S. Engineer Office, Buffalo, N. Y., for furnishing materials (except iron) and building a shore protection on the lake side of the neck of the peninsula at Erie, Pa., also for furnishing the iron. The amount available is $53 000, and as much of the work will be done as the condition of the appropriation will permit. The total length of the protection including the 4 shore arms, is about 6,000 ft.; it consists of a row of oak piles, with oak waling pieces; sheet piling on the outer side with a third waling piece; also buttresses of 5 piles in groups at intervals of 30 ft.; in rear of the protection will be a brush mattress 20 ft. wide, weighted down by stone. The material required is as follows: *Iron*; 1, 01 bolts, 1-in. round, 34 ins. between head and nut; 1,218 bolts, 1-in. round, 24 ins. between head and nut; 2,160 bolts, ¾-in. round, 12 ins. between head and nut; 18,400 of 10-in. spikes, ¾-in. square; 310,000 lin. ft. of wire, No. 10, B. W. G. 14,700 lbs. *Piles*; 2,072 piles 23 ft. long; 148 piles of assorted sizes from 18 to 23 ft. long. *Timber*; 5,600 sheeting piles 4 × 12 ins. × 15 ft.; 400 sheeting pieces 4 × 12 ins., 10 to 12 ft., long; 18,000 lin. ft. of waling pieces 6 × 12 ins.; 416 binders 6 × 12 ins. × 7 ft. *Brush*; 5,413 fascines, estimated to contain 664 cords, choked tight; 748 poles. *Stone*; 8,512 cu. yds. J. C. QUINTUS, of Erie Harbor, Pa., is in charge.

Filter Plant.—The Water Commissioners of Norfolk, Va., have given the National Water Purifying Co., of New York, a contract for a purifying plant of 3,000,000 galls. daily capacity.

Iron Roof.—The following proposals have been received for an iron roof at the navy yard, Norfolk, Va.: Haugh, Ketcham & Co., Indianapolis, Ind., $12,000; King Iron Bridge & Mfg. Co., of Cleveland, O., $13,994; Bartlett, Hayward & Co., Baltimore, Md., $15,500; Smead & Co. Iron Works, Louisville, Ky., $15,850. The contract was awarded to Haugh, Ketcham & Co.

The Endolithic Marble Co. has been incorporated at Hempstead, N. Y., to manufacture artificial stone for decorative and building purposes. FRANK B. CARPENTER, EUGENE CORNELL, and others. Capital stock, $1,000,000.

The Hollenback Frog and Switch Co., of Chicago, has been incorporated by CHAS. E. RAMES, THOS. H. BROWN and WESLEY HOLLENBACK, to manufacture and deal in switches, frogs, etc. Capital stock, $500,000.

Vulcanite Paving.—The City Council of Indianapolis, Ind., has awarded a contract for vulcanite asphalt paving to the National Vulcanite Co., of New Jersey, at $11.50 per lin. ft. front on either side of the street.

Wharf and Piling.—At San Francisco, Cal., the American Bridge & Building Co. has the contract for repairing the Berry St. wharf at $13.25 per pile and $34.25 per M. B. M. for lumber. The San Francisco Bridge Co. has the contract for repairing the piling at sections 1, 2, 3 and 4 of the seawall at $12.87 per pile and $32.50 per M. B. M. for lumber.

Sewer Bonds.—At Colorado Springs, Col., the $50,000 sewer bonds have been sold to N. W. Harris & Co., of Chicago, at $1.01 5/8 per cent. H. C. LOWRIE, of Denver, is Consulting Engineer.

The Fox Island Drain Tile, Sewer Pipe & Terra Cotta Co., of Tacoma, Wash. Ty., has completed works on Fox Island with a capacity of 20,000 ft. of tile per week.

Roads.—The County Supervisors, at San Diego, Cal., have awarded contracts for the construction of 4 county roads to Proctor & Marriage, at $26,750.

Bridge Abutments.—The contract for the abutments of the bridge over the Miami and Erie canal at Middletown, O., has been awarded to H. E. Butine.

Tunnel.—At Zanesville, O., it is proposed to construct a tunnel under Muskingum Ave. from Chaps Run, in the 7th Ward, to the Muskingum river, a distance of 1,110 ft., with a fall of 8.69 ft. Mr. WM. DUNN has made an investigation for interested property owners, and estimates the cost at $2,800.

Public Buildings.—The following proposals have been received by the Supervising Architect, Treasury Department, Washington, D. C., for the completion of the post-office, court house, etc., at Oshkosh, Wis.: Larkworthy & Menkes, Quincy, $88,550; E. F. Gobel, Chicago, $89,389; R. L. Reynolds, La Crosse, $90,000; D. Larria & Rawlinson, La Crosse, $93,287.——The following proposals also have been received for the completion of the Federal building at Houston, Tex.: McCarthy & Baldwin, Washington, $58,647; R. L. James, New Orleans, $58,935; Kelly & Bros., New Orleans, $59,900; John O'Connor, Buffalo, N. Y., $63,605; James H. Coster, Baltimore, $72,256; Chas. Landburg, Chicago, $79,875.

Section Houses.—The following proposals for the construction of 8 section houses on the Butte branch of the Montana Central Ry., have been awarded by E. H. BECKLER, Chief Engineer, Helena, Mont.: W. H. Merritt, Helena, $12,770; Wm. Brennan & Co., Boulder, $12,590; A. J. Gray, Helena, $12,207; D. J. McNally & Co., Boulder, $11,900; O. G. Frederick & Mason & Co., Helena, $11,650; Adam Geis, Helena, $11,625; P. S. Kelley, Helena, $11,025; Nathan Sifton, Helena, $9,650; A. McCarthy, Helena, $9,436; J. J. Palmer, Helena, $9,360; W. H. Watson, $8,850; A. F. McKay & Co., Helena, $7,750. The contract was awarded to A. F. McKay & Co., on June 1.

Docks.—The contract for the extension of the docks of the East Tennessee, Virginia & Georgia R. R., at Brunswick, Ga., has been awarded to R. D. Meader and Littlefield & Tison.

Pumping Engine.—The Water Commission, Albany, N. Y., has decided to purchase a fourth pumping engine of 5,000,000 galls. capacity, to be placed at the pumping station on Van Rensselaer flats. The other three engines, of the same capacity, will be utilized at the new driven well plant in connection with this engine.

Brick Sidewalks.—At Pontiac, Ill., the City Council is experimenting with brick paving for sidewalks, and if it proves satisfactory it will be substituted for the present pine plank sidewalks.

WATER.

Water Supply of Allegheny, Pa.—In the volume of municipal reports for 1887 is the joint report of the City Engineer and Superintendent of Water-Works, on the proposed improved water supply, together with other reports on the same matter and analyses of water from different sources. Reservoirs are proposed at a site near Hoboken Station on the West Penn. R.R., at an elevation of 270 ft. above low water. It is proposed to build two reservoirs, separated by a dividing wall; the banks to be of puddle and brick paving. The large reservoir will be 667.2 ft. by 555.2 ft., with a capacity of 57,457,552 galls. at the flow line; the smaller one will be 567.2 ft. by 555.2 ft. at the flow line, with a capacity of 48,014,836 galls., making a total capacity of 105,472,388 galls. The rising main, including influent pipe, will be about 4,000 ft. long, and the distance from the reservoirs to the present 36-in. mains will be about 9 miles. The delivery mains will be a double line of 48-in cast-iron pipe, costing $1,454,000; or a single line of 60-in. steel pipe, costing $997,208.90. The rising main will be a 50-in. steel tube, ⅝-in. thick, costing $46,784.75. The total cost is estimated as follows:

Reservoirs	$679,091.85
Pump house and engine	342,000.00
Intake pipe	34,680.00
Rising main	46,784.75
Delivery main (steel)	997,208.90
	2,099,765.50
Incidentals, 10%	209,976.55
Total	$2,309,742.05

Water-Works.—*Maine.*—Auburn. The water-works are to be extended.——Caribou. The Caribou Water Power Co. will build water-works and the city will pay $2,000 a year for hydrants. President, F. H. CLERGUE, of Bangor; Secretary, H. M. HEATH, of Augusta.

New Hampshire.—Dover. Work on the new water-works was commenced June 11, and about 175 men are at work laying pipe. There will be several miles of pipe and the works will cost about $275,000.——Milford. The Milford Water-Works Co. will probably begin work soon. F. A. HANCOX and M. DEAN have been investigating the matter and have reported to the company. They are opposed to the use of cement pipe.

Rhode Island.—Burrillville. The Water Supply Co still has its engineers at work and has not abandoned the idea of putting in water-works, with a supply from Wallum Lake.

Connecticut.—Willimantic. The Williams Aqueduct Co. will begin work at once on the new reservoir and has voted to assess all stock 5 per cent. to raise the necessary funds.

New York.—Port Chester. The village trustees have made a 5 years contract with the water company.——Honeoye Falls. Work is progressing on the new water-works.——Otsego. Work on the new water-works will be commenced shortly and be completed in the fall.

New Jersey.—Bound Brook. A gravity system of water supply is to be established by the Bound Brook Water Co.; J. M. THOMPSON, President. ISAAC S. CASSIN, of Philadelphia, Pa., is the Engineer.

Pennsylvania.—Dunbar. The Dunbar Improvement Association is negotiating with the Speer Sand Co. for a water supply for the town. The company has proposed to furnish water from its reservoir if sufficient revenue can be obtained to justify the expense of laying pipe in the town.

Maryland.—Salisbury. The city has stopped the pipe laying on account of the improper condition in which the contractor is leaving the streets.——Baltimore. Land has been acquired for the proposed Guilford reservoir; the site has an area of about 12¾ acres. Work is expected to be commenced this summer and completed in two years. The reservoir will have a capacity of 40,000,000 galls., and water will be pumped to it from the Gunpowder river. It will be used for distributing water to the northern annex of the city; the western belt will get its supply from the western, or park, reservoirs.

Indiana.——Greencastle. The water-works are to be commenced at once. They will be built by the company which has built the works at Jeffersonville, Ind.

West Virginia.——Charlestown. A water company is to be organized. B. C. WASHINGTON is interested.

Kentucky.——Pineville. The Pineville Water Co. has been organized and will commence operations shortly. President, F. A. HULL, of Danbury, Conn.; Vice-President, J. S. RAY; Treasurer, M. J. MOSS; Secretary, D. N. NASON.

Georgia.——Sandersville. A water supply system is projected.

Florida.—Orlando. The stand-pipe has a capacity of 110,000 galls., but the consumption of water from the water-works is about 300,000 galls. per day. Extensions of the pipe system are to be made and another pump put in.

Alabama.—Mobile. The Bienville Water-Works Co. has accepted a proposition from the city for a 20 years contract for water for 260 fire plugs at $50 per plug, the company to withdraw its claim for charges for water already used by the city.

Arkansas.—Camden. The City Council has granted a franchise to a company to build water-works.

Missouri.—Washington. An ordinance has been passed providing for a contract for a system of water-works and it will be put to public vote for ratification or rejection on June 18.——St. Charles. The St. Charles Water Co. is extending its pipe system.

Michigan.—Greenville. Pipe laying is in progress for the new system of water-works.

Illinois.—Cairo. The water company will put in a filter at the inlet crib. The mayor has stated that filtering at the crib proved unsatisfactory at Paducah and has suggested an artesian well supply.——Springfield. The city has voted in favor of the expenditure of an amount not exceeding $10,000 for building filter galleries at the water-works at the Sangamon river, for the purpose of improving and increasing the city's water supply.

Wisconsin.—Marietta. The water company is pushing the works to completion and will soon have them in operation.

Dakota.—Watertown. The water-works contractors have a large force at work and expect to have the works completed by September.

Nebraska.—Culbertson. Proposals for pipe, tank and a wind engine pump will be received shortly. The town will issue bonds for $4,000.

California.—Paso Robles. The Paso Robles Water Co. is pushing its works. A Dow compound condensing steam pump, with a capacity of 25,000 galls. per hour has been erected, the reservoir is nearly completed, and pipe laying is progressing.——Benicia. The Benicia Water Co. proposes to extend its present plant. Address H. KULLMAN, Secretary.

Texas.—San Antonio. The San Antonio Water Co. has purchased additional pipe and will extend and improve the works.

St. Paul, Minn.—In consequence of statements that the capacity of the present distribution system is insufficient for fire purposes, a test was made May 31 in the wholesale business district. According to report the fire department could not pump the hydrants dry in 3 hours' hard work, while the water pressure was not diminished to any great extent by the experiment. The Water Board accepts this as conclusive that the present system of mains in that territory is entirely adequate to the needs of the city. An official report of the test will be submitted.

Sewerage of Cornwall, Ont.—A report on the proposed system of sewerage has been made by WILLIS CHIPMAN, City Engineer of Brockville, Ont. The general slope of the town is from N. E. to S. W. The canal cuts off natural drainage into the St. Lawrence but the Government has provided drains emptying into a large manhole which connects with a culvert 900 ft. long passing under the canal and discharging into the river; the culvert has a fall of 4 ft. The "combined" and "separate" systems are considered, also the "restricted" system, which is a modification of the separate system with sewers to permit the admission of a limited amount of rain water, generally roof water only. Mr. CHIPMAN reports that the "separate" system is best suited to local conditions, but that the "restricted" system may be adopted on business streets and a "combined" system might be adopted on any street where the accumulation of street water is a nuisance. For the "separate" system it is recommended that no pipe smaller than 8 ins. be used, in order to avoid obstruction by foreign substances. For cellar drainage there are laid alongside the main sewer, but having no connection with it, one or two lines of agricultural tile. He recommended that stringent rules and regulations should be adopted governing plumbing and the use of all sewers, similar to the rules adopted in Brockville, where the "separate" system is being adopted, and he also points out that sewerage is more urgently needed since water-works have been put in.

Special Reports of Water-Works Construction.

THE ENGINEERING NEWS MANUAL OF AMERICAN WATER-WORKS is now being compiled, and will be *indispensable* to every manufacturer, engineer and contractor in any way interested in Water-Works construction and maintenance, and will be of great value to Water-Works superintendents and projectors of new works.

Superintendents of water-works and water companies will wish to see correct and complete data concerning their Works in our MANUAL, and to ensure this they should send in reports *at once* upon the blanks which we have already sent to every Water-Works office in the United States and Canada. Many have delayed their report, and if the blanks we intended for them have been lost in the mail, or mislaid, we will send more upon request.

We *must* have a report from every public water-supply system in North America, so those who reply to our inquiries at once will save a second inquiry. We also wish to know of *every* new Water-Works plant in process of construction, and of *every* new project in this line. We will send to any one desiring them, blanks upon which reports can be made.

Further details of the MANUAL will be advertised later. We abstract from our special reports for the MANUAL the following items of current interest:

AMENIA, N. Y., June 7, 1888.

EDITOR ENGINEERING NEWS:—The Amenia Water Co. expects to complete its works by October. Water will be pumped from gang wells by a 30 ft. Halladay wind-mill, and will be stored in a reservoir dug in the solid rock, 40 ft. in diameter and 20 ft. in depth. The reservoir is 803 ft. from the village and 130 ft. above the foundation of the highest building. A steam boiler and pump will probably be set to be used in case of necessity. The works will cost about $8,000, the capital stock for which is not all secured yet. The American Steam Heating Co. will have controlling interest and put in the plant.

JNO. R. THOMPSON, *Engineer-in-Charge.*

BOUND BROOK, N. J., June 9, 1888.

EDITOR ENGINEERING NEWS:—The Bound Brook Water Co. began the construction of their works on May 1 by clearing land for the reservoir. Contracts will be let July 1. The source of supply is Middle brook, and the mode by gravity to reservoirs. The mains will be 10-in. cast-iron, of which there will be 20¾ miles. The works are estimated to cost $30 000. Population of village, 1,500. JAS. M. THOMPSON is President, W. B. R. MASON, Secretary and Treasurer, and S. A. AYRES, Manager of the Company. ISAAC A. CASSIN, of Philadelphia, is Constructing Engineer.

S. A. AYRES, *Manager.*

MOUNT CLEMENS, Mich., June 9, 1888.

EDITOR ENGINEERING NEWS:—We have only *voted* to issue bonds to the amount of $50,000 for the construction of water-works. No engineer has been engaged, nor has the location of the works yet been decided upon.

G. W. ROBERTSON, *Prest. B'd of Water Commissioners.*

MILLEDGEVILLE, Ga., June 9, 1888.

EDITOR ENGINEERING NEWS:—The Milledgeville Water Co. proposes to put in a gravity system of water-works here, bringing water from springs three miles distant. Capital for construction is now nearly secured, the works being estimated to cost $30,000. Our population is 5 000. No officers have been elected and the matter is somewhat indefinite, but it will be settled July 8.

SAM. WALKER,

MONTEAGLE, Tenn., June 6, 1888.

EDITOR ENGINEERING NEWS:—The Nashville, Chattanooga & St. Louis Ry. Co. are putting in a system of water-works at this point to furnish a domestic supply for the summer residents, of which there are about 500. Water is to be pumped from a spring to a tank on a mountain. The company is putting in the works, using a Worthington pump and buying the pipe of the National Tool Co.

B. S. BLACKIE, *Asst. Engr. N. C. & St. L. Ry. Co.*

MORRISTOWN, Tenn., June 9, 1888.

EDITOR ENGINEERING NEWS:—Our population is 4,000. Water works are badly needed and the question is being discussed by citizens, contractors and a committee from our City Council. No positive steps have yet been taken although several propositions have been received and some prospecting done. J. C. HODGE is Chairman of the Water-works Committee.

W. A. JONES.

NICHOLASVILLE, KY., June 6, 1888.

EDITOR ENGINEERING NEWS:—Our population is 3,000 and our water supply is from wells and cisterns. No contract has yet been made for water-works although the matter has been talked of.

Z. D. YOUNG.

BUSHNELL, ILL., June 8, 1888.

EDITOR ENGINEERING NEWS:—We are now preparing to test a water-vein and if it affords a sufficient supply the city will put in a stand-pipe system for which $10,000 has been voted.

O. C. HICKS, *City Clerk.*

VINTON, IA., June 8, 1888.

EDITOR ENGINEERING NEWS:—We have just decided by a vote of the people to construct a water-works plant and will be ready for contracts later.

J. E. MARIETTA, *Chairman Finance Committee.*

WASHINGTON, Mo., June 8, 1888.

EDITOR ENGINEERING NEWS:—An ordinance giving to the Inter-State Gas & Water Co. the right to put in water-works here will be voted on by the people June 18. Our population is 4,500, and our present water supply from cisterns. It is proposed to pump water from the Missouri river to a stand-pipe. The estimated cost of the system is $5,000 and the necessary capital has been secured. The proposed date of beginning work is July 1 and the time allowed for completing it is six months. THEO. PLATTE is President of the company, and W. H. Bryan their Engineer.

W. H. HAZLEHURST, *Clerk of Water Committee.*

BATESVILLE, ARK., June 9, 1888.

EDITOR ENGINEERING NEWS:—The Batesville Water & Electric Light Co. proposes to put in water-works here, probably adopting the stand-pipe system, costing between $25,000 and $30,000. They have ready cash for the construction of the works. JNO. F. ALLEN is President of the company. It is hoped that work will begin at an early date. Our population is 2,725.

A. A. WEBBER.

We have received from Mr. W. S. KUHN, of Pittsburg, Pa., manager of the American Water-Works & Guarantee Co., 19 reports for use in the the MANUAL. Most of these works are owned or managed by the above company. They supply a combined estimated population of 225,000, the places varying in size from 1,200 to 40,000 and the cost of the works as far as given, ranging from $63,000 to $600,000.

Annual Reports.

Allegheny, Pa.—The principal reports of the city of Allegheny for the year 1887 have been issued in book form. The book contains a list of members of the city government; the reports of the mayor, comptroller, assessor, treasurer, sinking fund commissioner, solicitor, engineer, chief engineer of the fire department, street and sewer committee, street commissioners of the eastern and western districts, committee on wharves and landings, committee on surveys, committee on roads, road commissioner, superintendent of water-works, committee on gas, etc.; also special reports on a better water supply. The ordinances passed during the year are given in full. The report of CHARLES EHLERS, City Engineer, states that 8,067.9 ft. of sewer were laid, and gives tables of sewer and street work done during the year. The report of EDW. ARMSTRONG, Superintendent of Water-Works, shows that 35,148 ft. of pipe were laid, 131 hydrants and 265 stop gates set. The total pumpage was 17,823,500 galls., an increase of about 25 per cent. over the preceding year, and if this rate continues it will be necessary to increase the pumping plant. The report forms a book of 571 pages, well printed on good paper, illustrated with views of the city hall, free library, etc., and handsomely bound in cloth. It contains much matter of general interest in addition to the statements and very full tables showing the work done during the year. The reports on water supply are of special interest and are noted elsewhere.

Cincinnati, O.—The Chief Engineer of the Board of Public Affairs, H. J. STANLEY, has presented his report for 1887. He reports that after having visited other large cities he finds the granite and asphalt paved streets of Cincinnati equal to the best he has seen. The city has an area of 24 sq. miles, with 539.06 acres of parks. There are 98 miles of bowlder paving on avenues, streets and alleys, 112 miles of macadam, 6 miles of limestone, 7 miles of wood, 16½ miles of granite, 5 miles of asphalt, and 14 miles of macadamized turnpikes; total of improved avenues, streets and alleys, 258½ miles; total of unimproved, 221 miles; grand total, 479½ miles. During the year 9,965 miles of sewers were built, and there are now 84.7 miles of pipe and brick sewer, 2 drop basins, 937 "A" catch basins, 141 "C" catch basins, 118 inlets, 5,384 taps, 410 round manholes and 503 oval manholes. There were 3 foot bridges and one road bridge built, and a contract has been awarded to John W. Gaffney for the abutments of the bridge over Hunt St. at McMillan St.; estimated cost, $21,500; work has been commenced. There are 365 miles 3,619 ft. of gas mains and 7,287 gas lamps; also 1,453 gasoline lamps. For sidewalks the "artificial stone" prepared with English Portland cement gives the best results, and the primitive brick walls are being replaced with cement and freestone paving. It is recommended that the design for a single span through bridge at Hunt St. be abandoned and a double span, with floor situated midway between the chords, substituted; the cost would be about the same. The report contains tables of work done and a map of the sewerage system.

RECORD OF NEW WATER-WORKS CONSTRUCTION.

(Specially Communicated.)

(CONTINUED FROM PAGE 482).

Bessemer, Ala.—The works were commenced Oct. 15, 1887, and completed early in June, 1888. They were designed by B. B. GORDON, and the constructing engineers and contractors were Scovel & Irwin, of Nashville, Tenn. The pumping machinery was furnished by the Geo. F. Blake Mfg. Co., of New York; the pipe and specials by the South Pittsburg Pipe Works, South Pittsburg, Tenn.; the valves and hydrants by the Bourbon Copper & Brass Works, of Cincinnati, O., and the stand-pipe by J. P. Witherow, of Pittsburg, Pa. The supply is taken from two small streams fed by springs, and there are two dams giving a storage of 5,000,000 and 3,000,000 galls. respectively. The water flows by gravity from the dams to the pumping pond, whence it is pumped to a steel stand-pipe, 20 ft. by 100 ft., by 2 Blake pumps of 1,000,000 galls. daily capacity each, with 45 H. P. Babcock & Wilcox boilers. There are 6 miles of pipe, and 20 hydrants; cast-iron pipe is used for the mains and wrought-iron and lead for the services. Ordinary pressure, 40 lbs; fire pressure, 75 lbs. Water is furnished to two 17 × 75 ft. furnaces of the De Bardeleben Coal & Iron Co., with 400 coke ovens, and to the Bessemer Rolling Mill (125 tons per day capacity); also to a number of smaller industries. The works are owned by the Bessemer Land & Improvement Co; President, WM. BERNEY; Superintendent, H. M. MCNUTT.

Bessemer is one of the new manufacturing towns in the Birmingham district and is built round a large blast furnace plant and a large rolling mill, and the demands of these plants were the main reasons for building such large works. The town is situated in the Jones valley, about 12 miles below Birmingham; the whole valley is short of water and recourse must be had to the supply of several small streams, fed by springs, but offering only a limited quantity. The company dammed two of these streams, having an estimated minimum flow of about 2,000,000 galls. and the storage capacity is about 10,000,000 galls. which is ample for the present. From these dams the water is led to a pond 100 ft. diameter and 6 ft. deep, thence pumped to the stand-pipe and then conveyed by a 12-in. main about a mile long to the distributing system in the town. The furnaces, coking plant and rolling mill pay a stated sum per annum for their supply. About 4 miles of pipe and 19 hydrants are to be put in at once. The works are expected to be self sustaining and profitable. The present population is 2,500.

Carthage, Ill.—The works were commenced on Oct. 1, 1887, and completed at the end of November, 1887. They were designed by G. EDMONDS, of Carthage, and the contract for the works complete was taken by the U. S. Wind Engine & Pump Co., of Batavia, Ill. The water is taken from a cistern of 2,000 barrels capacity, supplied by a flowing artesian well 1,800 ft. deep. The supply is pumped to a tank 20 ft. by 24 ft., 61,770 galls. capacity, at an elevation of 60 ft., by a 500,000 galls. Knowles duplex pump, 14 × 7 × 12, with 40 H. P. upright tubular boiler; direct pressure can be used. There are 2 miles of 4, 5 and 6-in. Wyckoff wood pipe, and 25 taps. Ordinary pressure, 40 lbs.; fire pressure, 160 lbs. Cost of works, 14,000; debt, $10,000; rate of interest, 6 per cent. The works are owned partly by the city and partly by the contractors. The city committee in charge is composed of T. G. SCOFIELD, JOHN ELDER and E. W. ROBBINS. The Superintendents are R. D. RUSSELL and JOHN SCHROEDER, of Batavia, Ill. The population of the city is 2,500.